THE ENGINEER

A Seven-Day Journal

British Non-Ferrous Metals Research Association

The thirty-first annual report of the British Non-Ferrous Metals Research Association, which was issued last week, says that last year there were considerable changes in membership. Resignations were received from some firms leaving trade associations through which their membership agreements were negotiated, but to offset that, there was a substantial accession of new members, particularly from firms in the user and electroplating fields. At the end of last year the total membership of the Association was 495. It included firms engaged in the production, manufacture and use of the main industrial non-ferrous metals, representing an important section of industry in the United Kingdom and the Commonwealth. Several pages of the report are naturally occupied by brief accounts of the researches in hand during 1950. They relate to copper, nickel and their alloys; aluminium, magnesium and their alloys; lead and tin and zinc and galvanising, and reference is also made to the general researches —such as work on metal finishing, soldering and brazing and spectrographic analysis—in which the Association has shown interest. The report records the reopening early last year of the laboratories at Regnart Buildings, Euston Road, London, N.W.1. Additions to the equipment of the laboratories were made later in the year, including a sub-press for the 500-ton hydraulic press, designed for the extrusion of lead and lead alloys under closely controlled conditions. Another item of new equipment is a 7kW high frequency furnace. This is a transportable unit and, on account of its flexibility, is proving very valuable in a variety of work in the general metallurgy laboratory.

Institute of Fuel

The annual corporate meeting of the Institute of Fuel was held at the Connaught Rooms, London, on Thursday morning of last week. The annual report of the council, which was presented, records a year of further progress and shows the total membership of the Institute as 3744, compared with 3550 at the end of 1949. After the formal business, the President, Mr. J. F. Ronca, A.R.I.C., A.M.I. Mech.E., delivered his address, entitled "Some Considerations of Policy, Thought and Words." The annual luncheon of the Institute followed, with Mr. Ronca presiding over a large company of members and their guests. At the luncheon, the Melchett Medal for 1951 was presented by the President, to Professor F. H. Garner, Ph.D., F.R.I.C., director of the Department of Chemical Engineering and Dean of the Faculty of Science in the University of Birmingham. The principal speaker at the luncheon was Sir Frederick Handley Page, who responded to the toast of "The Guests," which was proposed by the President. In his speech, Sir Frederick dealt mainly with the subject of technological education, emphasising how important it was that those now engaged in industry should pass on their knowledge to those who must follow. Industry, Sir Frederick said, was suffering from a lack of trained people possessing an adequate background of the technology of the particular art in which they were engaged. In a reference to the recent proposals for a Royal College of Technologists, he expressed his firm conviction that the professional institutions already in existence were quite able to give, in their particular spheres, the required recognition of professional attainment. A final toast—not on the programme—was proposed by the President and was very cordially endorsed by the company. It was that of the health of Sir William Larke, a past-president, who last Thursday celebrated his seventy-sixth birthday and was among the guests at the President's table.

Lloyd's Register Shipbuilding Returns

The returns, issued by Lloyd's Register of Shipping, for the quarter ended March 31, 1951, indicate that 337 steamers and motorships of 2,072,723 tons gross were under construction, an increase of 28,035 tons over the previous quarter. Fitting out afloat were 86 ships of 480,724 tons, and the remainder of the total were still to be launched. During the quarter 56 ships of 316,881 tons were begun, 55 ships of 241,483 tons were launched, 47 ships of 291,173 tons were completed, and 850 tons were suspended. For abroad there were 110 ships, totalling 740,066 tons—that is, 54,572 tons less than in December last, and representing 35·7 per cent of the total tonnage being built in this country. Oil tankers under construction increased by 5959 tons over the last quarter to total 97 ships of 1,152,323 tons, and representing 55·6 per cent of the tonnage being built in this country. Plans were approved and material ordered for 212 ships of 1,414,309 tons, of which oil tankers form 66 per cent. Abroad, 880 ships of 3,024,361 tons gross, being an increase of 250,296 tons on December last, are under construction. Figures for China, Poland, Russia are not included. During the quarter, 494,293 tons were laid down, 437,972 tons launched, 529,866 tons completed, and 38,192 tons suspended. Oil tankers being built abroad totalled 84 ships of 828,670 tons, which is 47,220 tons more than the previous quarter, and represented 27·4 per cent of the total tonnage. World construction amounted to 1217 steamers and motorships of 5,097,084 tons gross, an increase of 278,331 tons compared with the previous quarter; 40·7 per cent was being built in Great Britain and Northern Ireland. The oil tankers under construction in the world totalled 181 ships of 1,980,993 tons, an increase of 53,179 tons since December last, and was 38·9 per cent of the total tonnage. At the end of March 3,151,782 tons, or 61·8 per cent of the world tonnage, was under the inspection of Lloyd's Register. Of this total, 1,929,303 tons were under construction in Great Britain and Northern Ireland, and the remainder—1,222,479 tons—abroad.

British Railways' Summer Services

Mr. John Elliot, Chairman of the Railway Executive, last week announced improvements in British Railways' passenger train services this summer, which, he said, would include the acceleration of over 150 trains by ten minutes or more, and the introduction of twenty-three new cross-country services. The summer schedules, Mr. Elliot stated, would this year operate from June 18th until September 23rd, and the average weekly mileage to be run by passenger trains would be 4,300,000, which was about 11,000 miles less than last summer, but 340,000 miles more each week than provided by the current timetables. Mr. Elliot added that a saving of 57,000 miles a week had been achieved by the closing of certain branch lines and by the withdrawal of poorly patronised trains, but all except 11,000 miles of that would be absorbed by the running of additional holiday trains. He also announced improvements in several shipping services operated by British Railways, among them the introduction on on the Harwich–Zeebrugge train ferry cargo service of the new 3200 tons motorship "Norfolk Ferry." On the subject of rolling stock, Mr. Elliot said that there would be approximately 550 more carriages in service this summer than there were last. In all, about 42,000 carriages would be available to operate the holiday, suburban and other train services, giving, for the first time since the war, the same number of seats as in 1939. About thirty of the new standard locomotives would also be in service by the time the summer timetables started. Altogether, 122 standard engines were scheduled for completion by the end of the year. Finally, Mr. Elliot stated that more track would be completely or partially relayed this year than during the pre-war years. This year's programme covered 1973 miles, compared with 1934 miles in 1938.

Retirement of Mr. J. J. Carter

Mr. Joseph James Carter, who has been managing director of Crossley Brothers, Ltd., for the last thirty-five years, retired from that position last Monday, April 30th. He joined the firm as a boy sixty years ago, and, at the request of his fellow directors, will continue to serve on the board of the company and to act as chairman of Crossley-Premier Engines, Ltd. Mr. Carter is one of the best-known characters in the British oil engine industry, to which he has devoted the whole of his professional career. He was the moving spirit, in the years between the wars, in bringing into close co-operation those engaged in the diesel engine industry in this country, his efforts leading to the formation of the British Internal Combustion Engine Manufacturers' Association. Mr. Carter has also served as President of the British Engineers' Association and as a member of the Grand Council of the Federation of British Industries. In the course of his extensive travels at home and overseas, he has made many friends in the oil engine and other industries, all of whom will join us in wishing him long years of health and leisure in his well-earned retirement. His successor as managing director of Crossley Brothers, Ltd., is his son, Mr. H. Desmond Carter, M.I.Mech.E., a director and chief engineer of the company.

Iron and Steel Institute Awards

The Council of the Iron and Steel Institute has awarded the Bessemer Medal for 1951 to Mr. Benjamin Fairless, president of the United States Steel Corporation, in recognition of his distinguished services to the iron and steel industry. As Mr. Fairless will not be able to attend the forthcoming annual meeting of the Institute in London, Sir Charles Goodeve, Director of the British Iron and Steel Research Association, will present the medal during the annual general meeting of the American Iron and Steel Institute in New York on May 24th. Sir Charles is to lead the iron and steel productivity team which will be in the U.S.A. at that time. Other awards announced by the Iron and Steel Institute are: The Sir Robert Hadfield Medal for 1951 to Mr. William Barr, in recognition of his contributions to research in steel-making; an Andrew Carnegie Silver Medal for 1950 to Mr. A. B. Winterbottom, for his report on "Optical Studies of the Oxidation of Iron at Temperatures in the Range 20–265 deg Cent"; the Williams Prize for 1950 jointly to Mr. T. H. Harris and Mr. W. H. Everard for their paper on "The Use of the Oxygen Lance in British Electric Furnace Practice," and the Ablett Prize for 1950 jointly to Mr. D. A. Wise and Dr. L. N. Bramley, for their paper on "Proposed Method of Specifying Travel-Motion Performance for Steelworks Overhead Cranes." These medals and prizes will be presented at the Institute's meeting on Wednesday morning, May 30th.

The South Bank Exhibition

No. 1—RAIL TRANSPORT

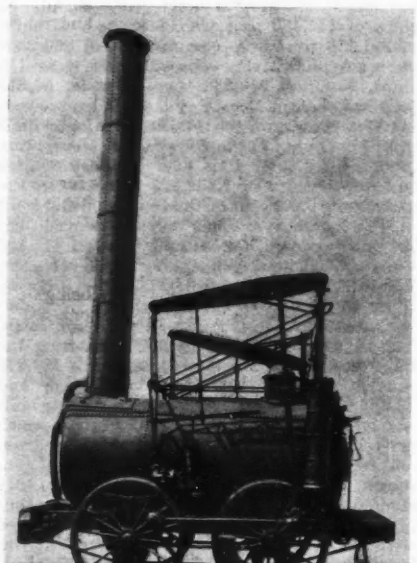
THE section of the exhibition on rail transport is on the ground floor of the "Transport and Communications" pavilion, and it not only deals with the railways of this country and their development, but also shows the influence that the work of British railway engineers has had on communication in many parts of the world. In a sequence of interesting panels there is shown the conception of rail transport, and the work in connection with the development of permanent way, equipment and rolling stock. As the country in which railways originated and which introduced, and has been primarily concerned in the development of, the steam locomotive, Britain has a unique history in transport. In tracing this history the panels have been used to good advantage to illustrate the work of many noteworthy pioneers. Although the actual examples of the early locomotives built in this country shown at the South Bank are few, visitors particularly interested will be easily able to supplement their knowledge by a visit to the Science Museum whilst they are in London. The two historic locomotives which are to be seen, however, provide an outstanding contrast to the many examples of locomotives of the most modern design which are exhibited.

The oldest locomotive exhibited is the "Agenoria," which was built in 1829 by Foster Rastrick and Co., at Stourbridge. Together with this engine is the "Buddicom" locomotive, built in the 1840s in France at the works of Allcard, Buddicom et Cie. The latter engine has been chosen for exhibition purposes as a typical example of the work of British engineers in establishing locomotive industries overseas.

The "Agenoria" was built for the Shutt End Colliery railway in Staffordshire, and is almost identical with the "Stourbridge Lion," built by the same firm. It was the first locomotive to run on rails in America. This engine, with its four coupled wheels of 48¾in diameter, has two vertical cylinders, 8½in diameter by 36in stroke, driving outside crankpins set at right angles to one another and fixed in the rear wheels. Grasshopper parallel motions are employed to guide the crossheads and, by attaching the connecting-rods to intermediate points of the beams in front of the cylinders, the crank throw is reduced to 27in. Loose eccentrics drive the slide valves and stops fixed to the axle control their motion and keep them in the correct positions for forward or reverse movement. The 10ft long, 4ft diameter boiler has a grate area of 8½ square feet and its heating surface is about 85 square feet. Visitors will note with interest how the engine frames are built of wood flitched with iron plates, which also form the axlebox guides. It will also be noted how high was the standard of British workmanship even in those early days of locomotive building in this country. This interesting old locomotive can be seen in the photograph reproduced on this page by the courtesy of the Director of the Science Museum, from which it has been loaned to the Festival authorities.

The "Buddicom" locomotive, which was lent by the French State Railways, is one of a series built for the Paris and Rouen railway, and reconditioned and restored to its original state in 1947. Two British engineers, Alexander Allen and William Barber Buddicom were primarily concerned in the design of this type of locomotive, which was well known as the "Crewe" class for many years in this country, and was first built by Allen at the Crewe workshops of the Grand Junction Railway.

When first built, the "Buddicom" had a calculated tractive effort of 3300kg at 85 per cent boiler pressure, and was intended for a maximum authorised speed of 80km per hour. Its slightly inclined cylinders are 355mm diameter by 535mm stroke, and are firmly fixed well forward to both the inside and outside frames. The driving wheels are 1720mm diameter and the maximum axle loading is 6300kg. In full working order the engine weighs some 17,000kg. The photograph we reproduce opposite shows the engine on exhibition at the Gare St. Lazare in Paris. Similar



THE "AGENORIA"

"Crewe" engines were used in large numbers in this country, Europe and Canada during the nineteenth century.

The modern locomotives of British design and construction in close proximity to these two old engines serve to accentuate the changes which have been made in steam locomotives during the past century, and show the types of diesel-electric, diesel-mechanical and electric locomotives which have been developed in relatively recent years.

One of the modern locomotives, a 300 h.p. heavy-duty diesel shunting engine, was built by Robert Stephenson and Hawthorns, Ltd., and it is illustrated in the Supplement included with this issue of THE ENGINEER. When looking at the modern lines and mechanical features of this locomotive and the striking contrast it presents to the engines of a hundred years and more ago, it will be remembered with interest that one of the founders of its builders was responsible for the famous "Rocket" of the Rainhill trials.

This shunting engine weighs some 40 tons in working order, and at 3·83 miles an hour (in low gear) has a tractive effort of 24,750 lb, at 7·02 miles an hour (second gear) 13,500 lb, and at 12·15 miles an hour (top gear) 7800 lb.

The locomotive has a six-cylinder, direct-reversing Crossley diesel engine developing 300 b.h.p. at 750 r.p.m., or 330 b.h.p. at one hour rating. Drive from the engine is transmitted through a Vulcan-Sinclair hydraulic coupling and a heavy-duty, three-speed gearbox, built by Bostock and Bramley, Ltd., to a spur gear on to the jack-shaft. The first and third gears are engaged through multi-plate clutches. The second gear is engaged by an involute tooth dog-clutch with a synchronising ring interposed between the driving and driven members to ensure engagement at synchronous speed. Clutch engagement is effected by compressed air and an interesting detail in the system is in that a brief application takes place in the third speed clutch when changing from first to second gear. This application is automatic and it maintains drawbar pull during the gear change.

In common with most modern diesel and diesel-electric shunting locomotives the driver's controls are duplicated on each side of the cab, which is roomy and gives a wide, unobstructed vision all round. Another improvement typical of the latest practice is the provision of quick and easy access to all parts for maintenance and inspection purposes.

A 660 b.h.p. diesel-electric locomotive, also to be seen amongst the exhibits, is one of an order for thirty-two similar units being built by the English Electric Company Ltd., for general service on the Tasmanian Government Railways. The order to which this locomotive was supplied is stated to be the first placed in this country for complete diesel-electric locomotives for Australia. These B_0—B_0 locomotives can, in addition to being used as single units, be coupled up in pairs or in threes to work as multiple units for hauling the different types of trains running in Tasmania.

The mechanical parts of the locomotive on show were designed and supplied by Vulcan Foundry, Ltd., and the power equipment by the English Electric Company, Ltd. This power equipment comprises a six-cylinder, four-stroke, supercharged diesel engine directly coupled to a six-pole traction d.c. generator, which supplies current to the four axle hung traction motors. Fabrication has been used largely in the construction of the locomotive underframe, superstructure and the swing bolster bogies.

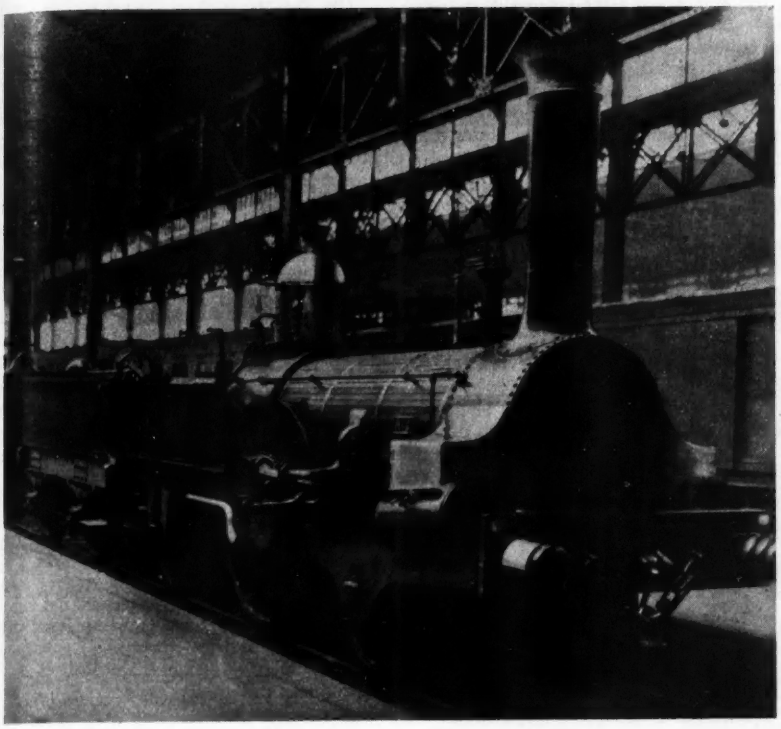
In full working order the locomotive weighs 55 tons and has a maximum starting tractive effort of 31,000 lb, the one-hour tractive effort being 15,800 lb at 9·2 m.p.h., and the continuous tractive effort 12,700 lb at 13·7 m.p.h. The maximum service speed of the engine is 55 m.p.h.

Small diesel locomotives for industrial establishments are made by many firms in this country, and a 7-ton "Planet" locomotive made by F. C. Hibberd and Co., Ltd., is exhibited. This little 0–4–0 unit is driven by a National 37 b.h.p. engine, and has a tractive effort of 3500 lb at 2·5 miles an hour and 2100 lb at 5 miles an hour, its haulage capacity on straight level track being 167 tons and 97 tons respectively.

In this make of diesel locomotive the gearbox incorporates two-speed spur reduction and bevel reversing gear, with spur gearing drive to a sprocket shaft coupled by chains to each axle. Changing speed through a constant-mesh gearbox is effected through cone clutches attached to each gear ratio, and sliding dogs give a positive drive for the reversing gear. A sliding selector shaft for forward or reverse drive is operated by compressed air.

As a result of the considerable increase

which has taken place in the underground mechanisation in mines in this country an interesting range of flameproof mine locomotives has been developed by British manufacturers. Typical of these locomotives designed for use at home and overseas are units exhibited by two makers, the Hunslet Engine Company, Ltd., and Ruston and Hornsby, Ltd.



"BUDDICOM" LOCOMOTIVE No. 3

The Ruston and Hornsby, Ltd., 75 h.p. locomotive for haulage work in coal and other gassy mines is illustrated on this page. This locomotive has a driving position at each end and the driver has only two control levers to manipulate, one for gear changing and the other for applying the air brakes.

The locomotive is of unit construction throughout, each unit, i.e., engine, radiator, gearbox, &c., being easily detachable without affecting adjacent units. This form of construction makes for simplified maintenance, and it is interesting to note that there are no working parts under the machine, so that any adjustments can be carried out without the use of an inspection pit. All parts of the locomotive, other than the main frame, axles and jackshafts, are completely interchangeable from one machine to another of the same type, irrespective of the gauge of the locomotive.

The machine has a four-speed, oil-operated constant-mesh gearbox, using low-pressure, hydraulically-operated cone clutches for each gear.

Drive from the engine is taken to an input bevel pinion which drives the clutch shaft through bevel gears which can be clutched to the shaft to give either a forward or a reverse motion. The selected clutch transmits the power to the final drive shaft through the reduction gears mounted on lay and intermediate shafts.

Gear changing is effected positively by means of a short hand lever working on a quadrant, and, on selecting a gear, oil is fed to the clutch shaft and to the appropriate clutch. The load is then taken up smoothly and without snatch.

Forward and reverse direction is selected by engaging the dog clutch between the bevel wheels of the clutch shaft and, to facilitate easy engagement, a synchro-mesh unit is incorporated.

An exhaust conditioner fitted to the main locomotive frame removes the irritant constituents of the exhaust before passing them to the atmosphere. When working in gassy mines or explosive areas, flame traps are fitted to the inlet side of the engine and to the exhaust outlet from the conditioner box.

Typical of the special mobile equipment made in this country for railways overseas is a motor inspection car which is included amongst the locomotive exhibits. Saloon cars of similiar design have been supplied to railways in many parts of the world by the makers, D. Wickham and Co., Ltd.

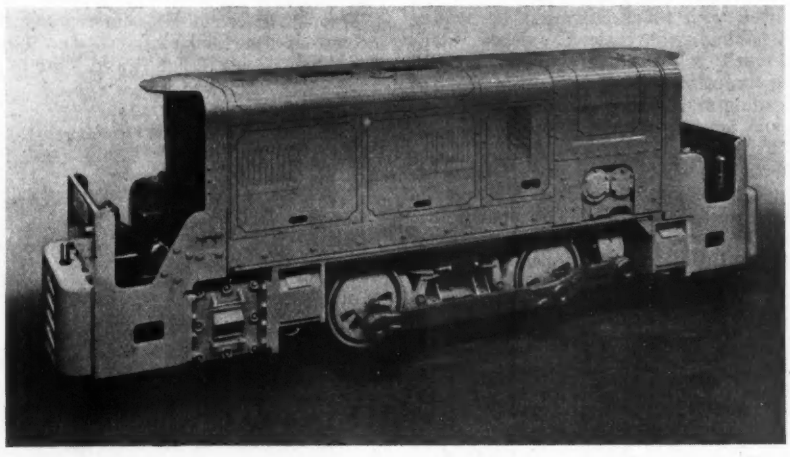
The car, which is illustrated overleaf, has a welded steel channel frame with an insulated double-walled steel body. It is fitted with an 85 b.h.p. Ford "V 8" engine, from which the power is transmitted through a four-speed gearbox and a reversing final drive gearbox. Seats are provided for six or nine passengers, and the driving controls are duplicated at each end to facilitate driving in either direction. Large windows fitted with safety glass give the passengers an unobstructed view of the permanent way as the vehicle travels along the line.

The largest exhibit in the transport section is a 2–8–2 "W.G." class locomotive, built by the North British Locomotive Company, Ltd., for the Indian Government Railways. It is a typical example of up-to-date design of steam locomotive and is representative of many hundreds of locomotives of different types built by British manufacturers for countries in all parts of the world. This locomotive, which is one of a hundred similar engines supplied to the same order, is illustrated in Plate 2.

The principal dimensions of the locomotive, which is intended for heavy freight train haulage, are as follows :—

Cylinders, dia. and stroke	21½in × 28in
Wheels :	
Coupled, dia.	5ft 1½in
Front truck, dia.	3ft
Hind truck, dia.	3ft 7in
Tender bogie, dia.	3ft 7in
Wheelbase :	
Coupled	17ft 1in
Engine	36ft 3in
Engine and tender	68ft 6in
Height :	
Rail level to boiler centre	9ft 6in
Rail level to top of chimney	13ft 10½in
Heating surfaces :	
Tubes	1962 sq ft
Firebox, including siphon and arch tubes	275 sq ft
Total evaporative area	2237 sq ft
Superheater	683 sq ft
Total	2920 sq ft
Grate area	45 sq ft
Boiler pressure	210 lb per sq in
Weight :	
Engine in working order	101 tons 17 cwt
Tender in working order	71 tons 16 cwt
Engine and tender in working order	173 tons 13 cwt
Adhesive weight	73 tons 12 cwt
Adhesive factor at 85 per cent boiler pressure	4·2
Tractive effort at 85 per cent boiler pressure	38,890 lb

The 4½in thick steel frames are connected at the rear by a heavy cast steel cradle and at the front by a steel casting in which the front dragbox and buffer beam are incorporated. Cross staying is provided by cast steel cross stretchers, and the frame pedestal wedges and shoes are steel forgings fitted with renewable manganese steel liners. Overhung laminated bearing springs are fitted and the flanges of the coupled axleboxes are of sufficient thickness to allow for the fitting of



75 H.P. MINE LOCOMOTIVE

channel liners after wear. Spring compensation is arranged in two groups—between the front truck, leading and intermediate wheels, and between the driving, trailing and hind truck wheels.

The whole of the revolving masses and 52 per cent of the reciprocating parts are balanced, the reciprocating balance being 14, 15, 10 and 13 per cent respectively in the leading, intermediate driving and trailing wheels.

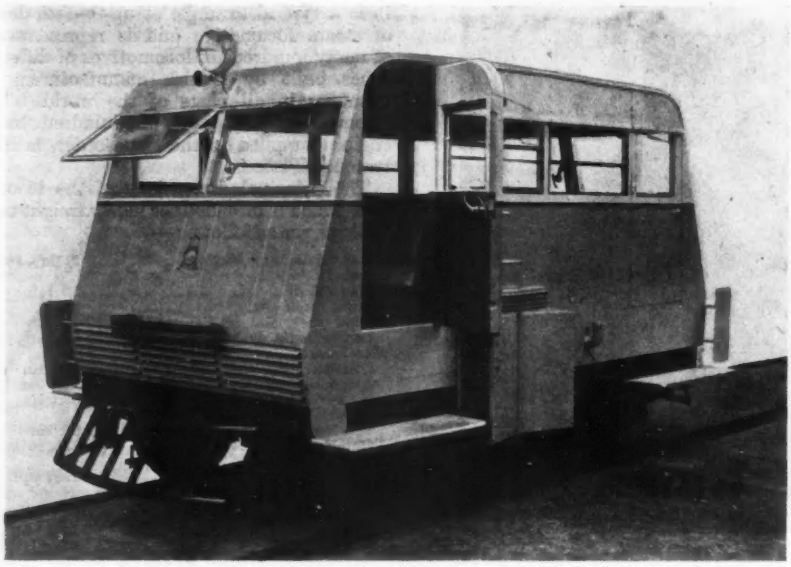
The cast steel cylinders joined on the vertical centre line are integral with the smokebox saddle and renewable cast iron liners are fitted to both the cylinder barrels and the steam chest. The piston valves, 12in diameter, are actuated by Walschaerts valve gear, and have a maximum travel of 7$\frac{9}{16}$in and a cut-off at 80 per cent in full forward gear.

Hard grease-lubricated bronze floating bushes are fitted to the coupling and connecting-rods, whilst cast iron bushes on the motion have soft grease lubrication. Roller bearings are fitted to the ends of the eccentric rods. The leading and hind trucks are fitted with roller bearings, the leading truck having a conventional axlebox. The hind truck is of radial arm design with spring control side check gear. Side play of the leading and trailing trucks is limited to 6$\frac{1}{2}$in and 5in respectively, and allows curves of 573ft radius to be negotiated.

The boiler, which has a barrel consisting of three rings, has 118 tubes, 2$\frac{1}{4}$in outside diameter and 38 flue tubes 5$\frac{1}{4}$in outside diameter, the distance between the tube plates being 15ft 10$\frac{5}{8}$in. A round top radial stayed firebox has an inner fabricated steel firebox and incorporates a Nicholson thermic siphon. At the front of the firebox the boiler is supported by oil-lubricated expansion shoes attached to the foundation ring. Holding-down clips are fitted to maintain the shoes in contact with bearing slides on the frame cross stay. A breathing plate is bolted to the frame cradle casting and the back of the foundation ring, and frame deflection plates located between the coupled wheels reduce the bending stresses in the frame of the locomotive. The thirty-eight element "Melesco" superheater has an anti-vacuum valve and the "Joco" regulator in the dome is operated by a ramshorn handle.

The driver's cab is particularly large and has a double roof with an open air space between. Windows are provided in the front plates and sliding steel louvred shutters are fitted on the cab sides. Steam brake equipment on the engine actuates blocks on all the coupled wheels, and vacuum braking is provided for the tender and train. In keeping with modern practice, electric lighting is provided and a powerful headlight is fitted to the front of the locomotive.

The double four-wheeled tender is of welded and riveted construction, and has a capacity for 5000 gallons of water and 18 tons of coal. Space is provided for the fitting of a mechanical stoker at a later date if required. The connections between the locomotive and tender consist of a drawbar, safety drawbar and spring-loaded rubbing block bearing on a facing strip on the engine hind buffer beam.



RAILWAY INSPECTION CAR

In addition to the various full-scale locomotives actually exhibited, a number of excellent models are arranged to show other kinds of engines made by other British manufacturers for various duties on home and overseas railways.

Amongst these models is one representing a locomotive of particular interest—the "Liberation" which was designed and built by the Vulcan Foundry, Ltd., for use by U.N.R.R.A. in its task of restoring internal communications in Europe after the last war. The locomotive was designed to include what was considered to be the best British, Continental and American practice, and its characteristics were chosen as those best suited to their purpose irrespective of the country of origin. It will be seen from the photograph of one of the engines which we reproduce on this page that, whilst they exhibited the basic ideas of British design many details of Continental and American practice were introduced.

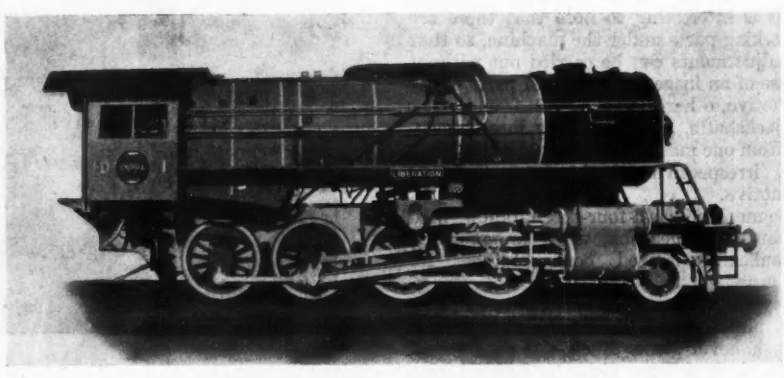
The boiler, with a working pressure of 227 lb per square inch, has a total evaporative area of 2933 square feet and has a grate area of 44 square feet. Two 21$\frac{5}{8}$in diameter by 28in stroke cylinders are fitted, with 12in piston valves actuated through a simple form of Walschaerts valve gear designed to provide a straight line drive from the eccentric crank to the piston valve spindle. In this valve gear a one-piece cast motion girder incorporates provision for carrying the slide bars, reversing link, reversing shaft and mechanical lubricators. By adopting this design not only was weight saved, but the amount of machining and handling required in manufacture was considerably reduced.

In full working order these locomotives weigh some 84 tons and their tenders 58 tons, and at 85 per cent boiler pressure they have a tractive effort of 43,800 lb.

The three main exhibits of British Railways are to be seen on a small siding near the "Transport and Communications" pavilion. These exhibits consist of one of the new standard 4–6–2 mixed traffic steam locomotives, a diesel-electric locomotive, and an electric locomotive built for service on the Manchester–Sheffield electrified line. Photographs of these three locomotives, which provide interesting examples of modern engines in use on British Railways, are reproduced in Plate 1.

The standard 4–6–2 locomotive exhibited is No. 70,004, the "William Shakespeare"; it is one of twenty-five similar engines being built this year. In this locomotive, as in the other standard types to be introduced by British Railways, the designers have made every endeavour to embody improvements calculated to increase mileage between repairs, give the maximum economy in operation, ease of access for servicing and repair, and a high degree of interchangeability of parts. It is the outcome of some two years' work by British designers, and is the first of twelve new standard types which it is intended will eventually cover the work of the present range of some 400 designs employed on the lines in this country.

A feature of this class of locomotive, which has already been described in detail in our columns, is that the engine and tender are carried on Timken self-aligning roller-bearing axleboxes throughout, while the bogie and coupled axles are carried on non-split common axleboxes.



"LIBERATION" LOCOMOTIVE

The main particulars of the locomotive are as follows :—

Cylinders (two)	20in by 28in
Coupled wheels	6ft 2in dia.
Wheelbase, rigid	14ft
Total weight in working order (engine)	94 tons
Boiler pressure	250 lb per sq in
Heating surface :	
Tubes : 40 large, 5½in O.D.	2,264 sq ft
136 small, 2¼in O.D.	
Firebox	210 sq ft
Total evaporative area	2,474 sq ft
Superheater	718 sq ft
Total	3,192 sq ft
Grate area	42 sq ft
Tractive effort	32·150 lb
Adhesion factor	4·23
Minimum radius curve (with specified gauge widening)	4½ chains
Tender :	
Coal capacity	7 tons
Water capacity	4250 gallons
Weight empty	21 tons 4 cwt
Weight full	47 tons 4 cwt

The diesel-electric locomotive is the first of three being built at the Ashford Works of the Southern Region, and is similar in most respects to the two diesel-electric units which have been in service for some time on the London Midland Region. This locomotive has a driving cab and duplicated controls at each end and for hauling heavy trains two units can be readily coupled together and worked as a single locomotive.

The power unit consists of an English Electric sixteen-cylinder, four-stroke vee engine, rated at 1600 b.h.p. continuously and 1750 b.h.p. for one hour, coupled to a d.c., self-ventilating, eight-pole generator with a continuous rating of 115kW. At this continuous rating the full load current is 1650A at 700V, and at the one-hour rating 1750A at 660V. In full working order the locomotive weighs 135 tons, and it has a maximum tractive effort of 31,200 lb, the effort at continuous rating being 14,000 lb. The main generator supplies current to six nose-suspended axle-hung traction motors driving the three axles on each bogie through single reduction spur gearing.

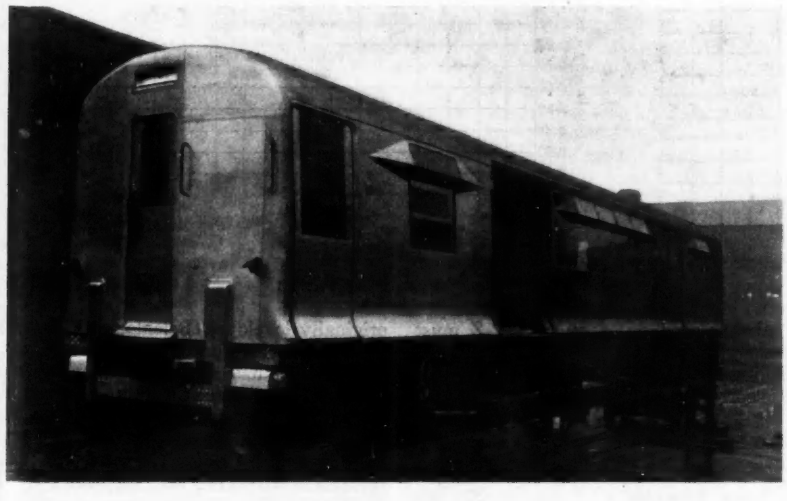
The locomotive, which is 63ft 9in long overall, has a fabricated underframe 60ft long, built up from two inner members of I-section and two light outer members of channel section. Cross members of plate and rolled sections carry the principal loads, such as the engine, generator, bogie centres, &c. From the underframe the load is transmitted to the bogies through four large segmental bearings, two at each bogie centre, and by four spring loaded bearers near the outer axles.

The electric locomotive is one of fifty-eight double-bogie, four-motor, four-axle units built by the Metropolitan-Vickers Electrical Company for the Manchester–Sheffield–Wath electrified lines. These locomotives have a continuous rating of 1360 h.p. at 56 m.p.h., and a one-hour rating of 1868 h.p. at 45 m.p.h. Their weight in working order is about 88 tons and they have a maximum starting tractive effort of 45,000 lb.

Twenty-seven other electric locomotives being built for the same system will be double-bogie, six-motor, six-axle equipments with a continuous rating of 2298 h.p. at 46 m.p.h., and a one-hour rating of 2490 h.p. at 44·3 m.p.h. Weighing about 102 tons these units will have a starting tractive effort of 45,000 lb.

Also exhibited in the rail equipment section is one of the new light alloy coaches now being built for service on the surface lines of London Transport. The coach body, the first of ninety similar units now under construction, is illustrated on this page. It is built of an aluminium-magnesium-silicon alloy and is some 37 per cent lighter than similar bodies of all-steel construction now in service. The body is of the stressed structure design standardised by London Transport, and is built on the same lines as the modern steel coach. Structurally, it follows standard practice, and, with the exception of a few members such as the body-end corner pillars and certain other details which are castings or forgings, it is built up from extrusions and sheet metal.

(To be continued)



LIGHT ALLOY COACH BODY

Historic Development of the Theory of the Flow of Water in Canals and Rivers*

By SERGE LELIAVSKY BEY, Ph.D., M.I.C.E., M.Am.Soc.C.E.

No. IV—*(Continued from page 535, April 27th)*

A MORE substantial alteration was suggested by the Austrian group, which tended to return to a universal formula containing no rugosity factor, but applicable to natural streams only. The fundamental principle of this solution has already been explained in connection with the "second" formula of Manning. One of the reasons for adopting this solution lay in the difficulties encountered by hydraulic engineers in attempting to obtain consistent rugosity factors from their observations on natural rivers. Thus, although the principle of a "rugosity coefficient" was undeniably correct, and, if reasonably applied, gave approximate but reliable results in designing canal schemes and pipe nets, its application to natural channels was a more involved problem; one of the reasons being that the physical nature of such channels changed with the height of the water level in the river. Whilst in certain cases the value of n rises with the discharge, a diametrically opposite correlation is observed to take place in other instances.

Obviously, such anomalies might have been attributed either to defects of the formula itself, or to some physical cause. The latter seemed to be the more probable explanation, for the same formula, when applied to artificial channels, gave reasonably consistent results.

It therefore appeared that, whilst the lining of an artificial channel was uniform enough to be represented by a single constant, the friction losses in a natural river could not be expressed by a single, consistent rugosity factor because the physical character of the channel changed with the levels and discharges. It was, consequently, preferable to dispense with this factor altogether, the natural formation of an alluvial river being believed to be a more reliable basis for obtaining numerically correct results. In the equations belonging to this school of thought, the hydraulic radius m was, therefore, replaced by the mean depth T, the symbol B representing the corresponding width of the river, while the rugosity factor was not represented at all.

For instance, Siedek[42] gave the formula (metric units) :—

$$v=\frac{T\sqrt{1000i}}{\sqrt[20]{B}}.$$

This equation was applicable, as it stood, to "normal" channels only, which conformed to the criterion

$$T_n=\sqrt{0\cdot0175B-0\cdot0125}.$$

Departures from this "normal" rule were classified and corresponding corrections of the basic velocity formula were given in the form of a rather involved set of formulæ and tables, which, nevertheless, constituted a self-contained and consistent solution for calculating the discharge of natural rivers.

A simpler set of equations, aiming at the same object, was suggested by Hermanek.[43] With some alterations, introduced subsequently by Forchheimer, his equations are as follows :—

For $T<1\cdot5$ metres ... $v=30\cdot7\ T^{0\cdot5}$

For $1\cdot5<T<6$ metres ... $v=34\cdot0\ T^{0\cdot75}$

For $T>6$ metres ... $v=44\cdot5\ T^{0\cdot6}$

* The opinions expressed in this article are those of the author and do not necessarily represent those of the Egyptian Ministry of Public Works.

[42] "Zeitschrift des Osterr. Arch. u. Ingen. Ver.," 1901.

[43] "Zeitschrift des Osterr. Arch. u. Ingen. Ver.," 1905.

Another formula was produced by Matakiewicz.[44] It read[45] :—

$$v=\frac{116i^{0.493+10i}}{2\cdot2+T^{2/3+0.15/T^2}}T.$$

Further equations, based upon the same principle, were developed by W. Lindboe,[46] Gröger,[47] and other Austrian engineers.

In other countries, however, the physical nature of the anomalies, which were the starting point of the solution adopted by the Austrian school, was explained in a different manner. For instance, in Egypt, it was attributed to the silt load carried by the Nile. Here again, as in Austria, France, India and several other countries, it was observed that Kutter's and Manning's n, as well as Bazin's γ, did not remain constant throughout the year, but were subject to very substantial alterations during the flood period, when the silt load carried by a natural river is particularly heavy. It was therefore suggested that the lower, heavily silt-laden layers of the moving water formed a kind of "slurry" and produced, therefore, a lubricating effect in damping the vortices created at the surface of contact between the moving water and the solid trough of the channel.[48]

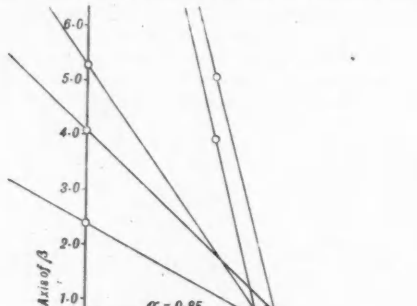


FIG. 18

Another simpler explanation of the silt effect upon the velocity originated from the obvious difference in the outer appearances of sand and silt channels respectively, when for some reason or other they are unwatered and their surfaces made capable of inspection. The characteristic ripples of a sandy bed are usually almost absent (or far less pronounced) in channels covered with deep silt deposits. It is therefore only natural to expect that the hydraulic efficiency of a channel must increase in the presence of silt, and vice versa. In order to investigate these and various other possibilities concurrent observations of velocities and silt charges were carried out at two discharge sites on the Nile, at Beleida and Khannaq respectively, in 1922.

The writer was in charge of the mathematical analysis of the recorded observations.[49]

The difficulty of the problem lay in the fact that there were so many variables, the individual effects of which had to be first separated before their respective influences upon the velocity could be traced. They were m, i and the silt contents Z (in grammes per metre cube of water). Fortunately, there were always two dates on which Z must necessarily be the same, during the rising and the falling stages of the river respectively. Let the corresponding equations be

$$v_1=f(Z_1)m_1^{\alpha}i_1^{\beta}$$

and

$$v_2=f(Z_1)m_2^{\alpha}i_2^{\beta}.$$

In these formulæ α, β and $f(Z_1)$ are unknowns, all other values being taken from the records, and therefore considered as given. Dividing one equation by the other, we get :—

$$\text{Log}\frac{v_1}{v_2}=\alpha\log\frac{m_1}{m_2}+\beta\log\frac{i_1}{i_2}.$$

Five equations of this general type are represented in Fig. 18. They constitute evidence from which the silt effect is automatically excluded, and may therefore serve to determine the individual effect of m and i on the velocity. The graphical method shown in the diagram yields, as the most probable solution, $\alpha=0\cdot85$ and $\beta=0\cdot72$.

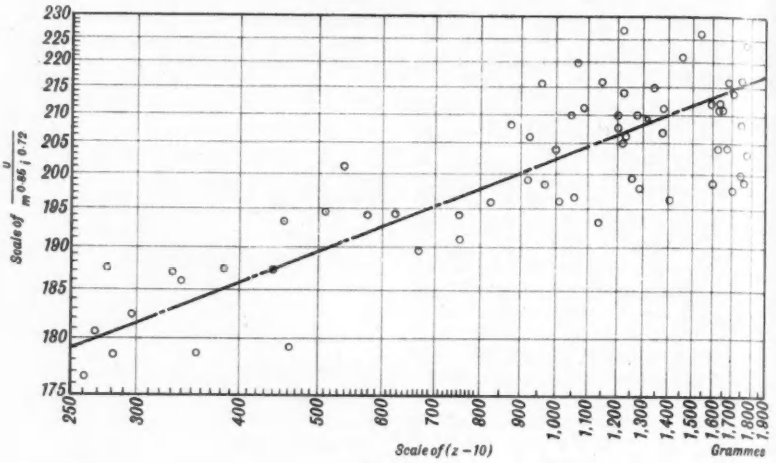


FIG. 20

Once this point is established the rest is elementary, i.e., values of $\frac{v}{m^{\alpha}i^{\beta}}$ are plotted in a logarithmic chart against $Z-10$ (see Fig. 20), which gives the straight line

$$\text{Log}\left(\frac{v}{m^{\alpha}i^{\beta}}-147\right)=0\cdot383\log 3\cdot92(Z-10)$$

and

$$C=(147+3\cdot92(Z-10)^{0.383})R^{0.35}i^{0.22}.$$

When plotted against actually observed velocities this equation is a remarkably good fit, not only for the site for which it was originally developed (Beleida, see Fig. 19), but also for Khannaq (see Fig. 21).

This, of course, cannot be taken as a strict proof of the theoretical assumptions underlying the investigation, for other equations may also be made to fit the available set of records. Such is, for instance, the simple formula $v=0\cdot0218\times mi$, suggested by Dr. Phillips.[50] But the fact that a consistent,

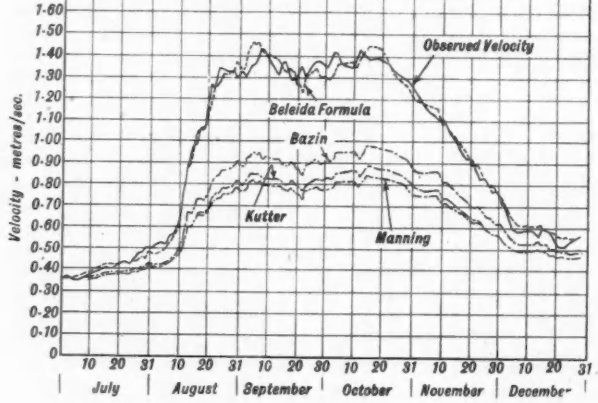


FIG. 19

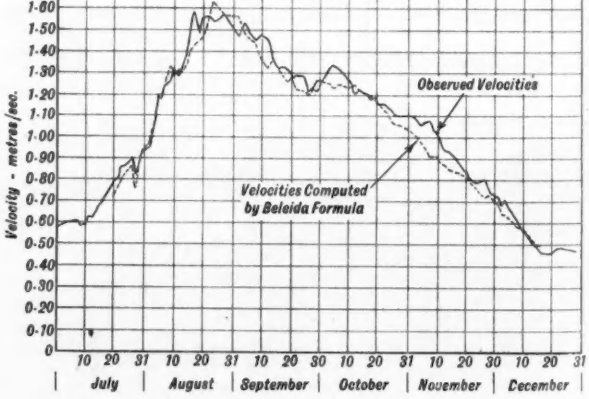


FIG. 21

[44] "Zeitschrift für Gewässerkunde," 1911.

[45] All the formulæ of the Austrian group are given here in metres.

[46] "Zeitschrift für Gewässerkunde," 1910.

[47] "Zeitschrift des Osterr. Arch. u. Ingen. Ver.," 1913, 35, and 1914, 18.

[48] A. B. Buckley, "The Influence of Silt on the Velocity of Water Flowing in Open Channels," Min. of "Proc.," I.C.E., 1922/23, Part II, page 183.

[49] Min. of "Proc.," I.C.E., 1922-23, Part II, page 207.

[50] Min. of "Proc.," I.C.E., 1922–23, Part II.

logically developed equation is capable of representing the silt effect on the velocity is worth record, as militating in favour of the existence (or probability) of physically significant correlations.

Further confirmation of the point has lately been supplied by the experiments carried out in the Co-operative Laboratory of the Soil Conservation Service, U.S. Dept. of Agriculture, by Professor Vito A. Vanoni.[51] These experiments were planned and conducted according to the latest methods of laboratory practice. A trough, 33½in wide and 60ft long, was arranged in such a manner that the slope and discharge could be varied at will, and also means were provided in order to mix in the required quantities of sediment of various sizes. The effect of the suspended load in reducing the resistance was clearly seen. The reduction of both Manning's n and d'Arcy-Weisbach's f due to the addition of supported sediment is obvious from the figures in the tables appearing in the quoted paper. This reduction does not seem to be affected by the size of the grain, but is greater for the low flows than for the high flows. There is an indication that the resistance decreases as the sediment increases. According to Professor Vanoni, the phenomenon can be explained by the effect of the sediment in reducing turbulence. To keep the sediment in suspension work must be expanded. The corresponding energy is supplied by the turbulence, which is damped and reduced in intensity when giving up this energy.

Further investigations along this line of enquiry might possibly throw more light on the physical interpretation of the observed interrelation between silt load and velocity.

Another question which for long has attracted the attention of many hydraulic investigators concerns the true physical significance of Chézy's "hydraulic radius" m. For more than a century this factor has been universally used in the routine of hydraulic calculations relating to open channel flow and, on the whole, has given satisfactory results within the range of practically admissible approximation. But there has always been a lingering doubt amongst progressive designers as to whether this factor supplies the best solution for comparing the relative hydraulic advantages of different shapes of channel sections. The rather elementary approach of the original Chézy theory cannot be taken, in the light of the modern mechanical analyses, as substantiating theoretically the use of this factor, and additional evidence has gradually accumulated showing that it does not cover the case entirely. For instance, in Bazin's investigations the value of m afforded a correct basis for estimating the relative hydraulic efficiencies of rectangular, trapezoidal and triangular sections, but underestimated the efficiency of a semi-circular section as much as 10 per cent. Here, therefore, there was incontrovertible evidence showing that, though m was a generally sound basis for comparing sections, it had to be replaced by another geometrical parameter if greater precision and deeper insight were aimed at.

As there are two diametrically opposed tendencies in connection with this problem, it deserves further attention, in the light of the more recent hydraulic research.

Up-to-date scientific evidence on the subject, in so far as open channels are concerned, is rather meagre as compared with that of pipe hydraulics. The question must therefore be considered by analogy with the flow in pipes and closed conduits, which have been thoroughly investigated during the last twenty or thirty years.

(To be continued)

[51] See "Transactions," Am.S.C.E., Vol. III, 1946, page 67, "Transportation of Suspended Sediment by Water," by Vito A. Vanoni.

British Industries Fair

No. II—*(Continued from page 532, April 27th)*

THE British Industries Fair opened on Monday, April 30th, at Castle Bromwich, Earl's Court and Olympia and will remain open until Friday next. Some of the exhibits to be seen at Castle Bromwich are described herewith.

International Combustion, Ltd.

Following its practice of recent years, International Combustion, Ltd., 19, Woburn Place, London, W.C.1, is exhibiting a model of one of the boiler installations under construction. The model to be seen at this year's Fair is of the plant for the Drakelow generating station of the British Electricity Authority. Each of the four boilers being built for this station is one of the company's pulverised fuel fired radiant units with an output of 515,000 lb per hour at 1550 lb per square inch and 1060 deg. Fah., with feed water at 430 deg. Fah. The combustion chamber, which has a volumetric capacity of 35,000 cubic feet and is some 85ft. high, is completely cooled with a dry ash hopper; the secondary superheater is of the pendent kind and the primary of the horizontal drainable design. A steaming "Senior" welded economiser is in three banks with the outlet directly connected to the rear steam drum, and the heat recovery equipment incorporates a regenerative air heater.

Each of four "Lopulco" units is connected to one pulverised fuel tilting burner in each corner of the furnace and control of the final steam temperature is by means of these burners, which give, in effect, a furnace adjustable as regards the heat release zone.

The boiler drums are of solid forged carbon steel, 32/36 tons tensile, the steam drums being 5ft internal diameter and 5⅝/5in thick (front and rear respectively). Electric arc welding is being used largely in the assembly of the boiler and furnace tubes and reduces to a minimum the distributing and collecting headers. Welding is also largely used in the construction of the boiler casings to produce a dust-tight assembly.

Also to be seen on the firm's stand is the "Dynocone" solid bowl continuous centrifuge, which is shown handling a brine mixture. It discharges the de-watered solid and the effluent continuously and has a solid retaining vessel for the dewatered material.

The "Dynocone" centrifuge, illustrated in Fig. 8 consists essentially of a horizontally revolving steel shell, in the form of a conical frustum, in which a screw conveyor rotates at a slightly greater speed. When the feed is admitted, both liquid and solid constituents tend to be thrown by centrifugal force to the large end of the shell. Solid material, by reason of its greater specific gravity, is deposited on the side walls of the shell, from which it is moved by the screw conveyor to the small end of the machine, being progressively dewatered during its passage by centrifugal action. The separated liquor increases in volume until there is a sufficient quantity to overflow through the ports in the large end of the shell.

The outer shell of the centrifuge is a single unit, fabricated in steel. Its screw conveyor is built up on a heavy-gauge steel tube, one end of which is fitted with a splined driving shaft. The complete revolving unit is carried on roller bearings, with a ball thrust bearing to take up the axial load, and the whole assembly is balanced. The main journal bearings are mounted on a heavy combined base plate of cast iron, which also supports the trough.

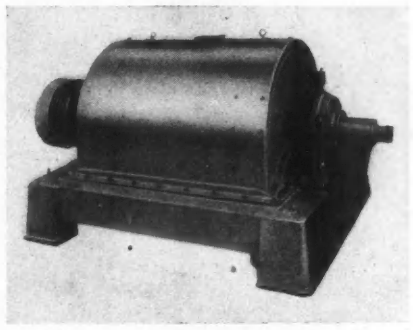


FIG. 8—CONTINUOUS CENTRIFUGE —INTERNATIONAL COMBUSTION

The centrifuges are made in two standard sizes, the larger of which has a conical frustum, 36in diameter and 50in long, the smaller machine having a diameter of 24in and a length of 24in. A multiple vee belt is employed for the drive, and the differential speed between the shell and the conveyor is obtained by a compound epicyclic gear, housed in the driving pulley. The conveyor is driven by a separate motor in order to relieve the main gearing of any undue strain, at the same time giving a simple means of adjusting the differential speed between the shell and the conveyor. Liquor level in the interior of the rotor is adjusted by ported discs in the shell end plate.

Bronx Engineering Company, Ltd.

A three-roll plate bending machine and a 60-ton press brake have been selected for exhibition by the Bronx Engineering Company, Ltd., of Lye, near Birmingham, from the range of equipment the company makes. The press brake, to be seen in Fig. 9, has a capacity of 8ft by ¼in mild steel, and has a number of improvements designed to facilitate tool setting and operation. It has a 3in stroke with a 6in ram adjustment and is designed for thirty strokes a minute.

The frame of the machine is of welded steel construction, and its drive is taken by vee belts from the main 5 h.p. motor to a pulley integral with a flywheel clutch and a brake. All these drive units are mounted on a first motion shaft carried on anti-friction bearings. From this first motion shaft the drive is taken through steel helical gearing to the second motion shaft. Double reduction pinions at each end of the frame take the final drive to twin eccentric shafts carried in the steel crown in large phosphor-bronze bearings. Cast iron pitmans fitted with phosphor-bronze worm wheels and high-tensile spherical-ended screws transmit the power to the top beam of the machine.

A ram stop mechanism is fitted, so that the press can be set for single stroke, coming to rest automatically at top dead centre.

By moving a lever the mechanism is disconnected, and the machine works as a normal press brake. Inching of the top beam can be carried out with the multi-plate dry clutch at any position of the cycle. Motorised power adjustment of the top beam is by a 2 h.p. motor provided with safety limit switches. This motor, used for operating the top beam for die-opening adjustment, is mounted on a bracket integral with the left-hand side connecting-rod. The limit switches are incorporated to prevent overrun of the top beam when being moved for tool adjustment either up or down.

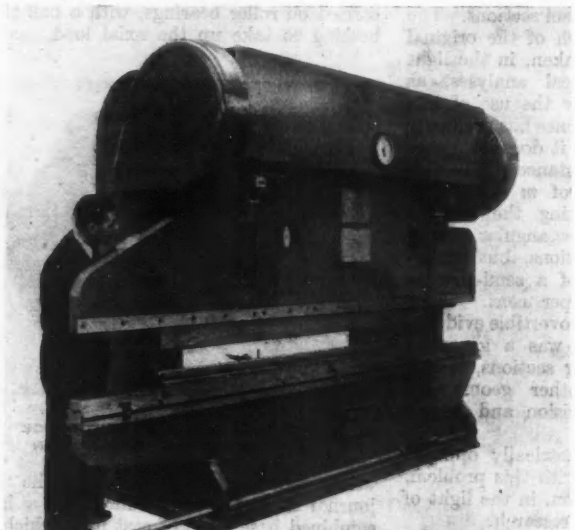


FIG. 9—60-TON PRESS BRAKE—BRONX

Bottom dead centre is indicated by a large dial let into the top crown at the front of the press brake. Counter indicators are provided for each connecting-rod to facilitate tool changing.

FERGUSON PAILIN, LTD.

The main exhibit in an interesting display of high-voltage switchgear made by Ferguson Pailin, Ltd., Manchester, 11, is a 33kV, 750MVA indoor non-extensible type ring main equipment (type "VSLP.10/IVS"), which was specially developed for 33kV distribution in the Merseyside area. It comprises the well-known "VSLP.10" vertically isolated, phase-segregated, metal-clad unit with "IVS" wing isolators on each side, as shown in Fig. 10. With this arrangement substation equipment can, to a great extent, be standardised throughout the distribution ring and the maximum flexibility and fault discrimination are obtained using only one circuit breaker per section. The circuit breaker is equipped for remotely controlled spring operation, and is displayed to facilitate internal inspection. The wing isolators are hand operated and fully interlocked with the independently operated earthing switch. They are also interlocked with the cover, giving access to the terminals provided for primary injection test purposes. A special arrangement of cable box is provided to permit cable entry from three different angles.

The protective scheme for the ring main installation is an arrangement of the "Translay" system and is shown diagrammatically in Fig. 11. The scheme is divided into a number of overlapping zones, each being equipped with current transformers and "HHTA" relays connected to compare total incoming and outgoing current for each zone. Under normal load and through fault conditions incoming current is equal to outgoing current for a healthy zone, and in these cases negligible pilot current flows and the relays remain inoperative. Under in-zone fault conditions total incoming and outgoing currents are unequal, resulting in currents in the pilots to operate the relays. If the fault is fed from both ends of the protected zone both "HHTA" relays will operate, energising the "ATA" multi-contact relays and tripping all the circuit breakers closed on to the faulty section. If, however, the in-zone fault is fed from one side only of the ring then only the "HHTA" relay on the side feeding the fault will operate to trip its circuit breaker; complete fault isolation will be effected by inter-

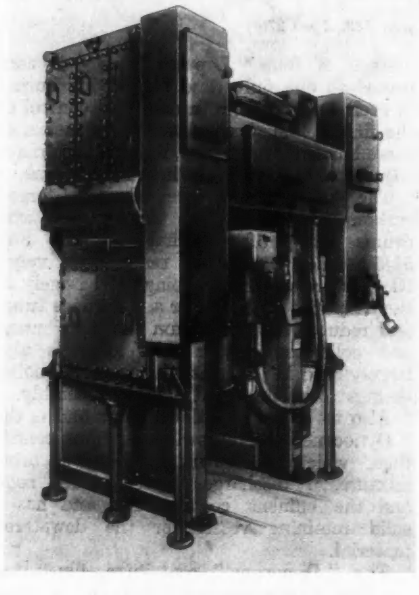


FIG. 10—33kV, 750MVA RING MAIN EQUIPMENT—FERGUSON PAILIN

tripping by d.c. injection into the pilots which energises the "DBT" pilot relay at the remote end of the zone.

Another exhibit is a multi-circuit control panel which incorporates complete control and circuit diagrams with automatic discrepancy signals for five circuits in the space of 2ft 6in. One circuit of the control board is interconnected with an 11kV, 250MVA duplicate busbar "VTBP.4" metal-clad unit to give remote control and demonstration of fully automatic operation under simulated fault conditions. The "VTBP.4" unit is an oil and compound-filled metal-clad equipment incorporating a vertically isolated, horizontal draw-out circuit breaker mounted on an independent carriage with integral raising and lowering mechanism. The circuit breaker is arranged for electrical solenoid operation and is equipped for service demonstration.

THOMAS GREEN AND SON, LTD.

The familiar range of road rollers to be seen on the outdoor stand of Thomas Green and Son, Ltd., of Leeds, includes one of the company's lighter models which has not previously been exhibited at the Fair. This three-wheel machine, the "P.R.R." model,

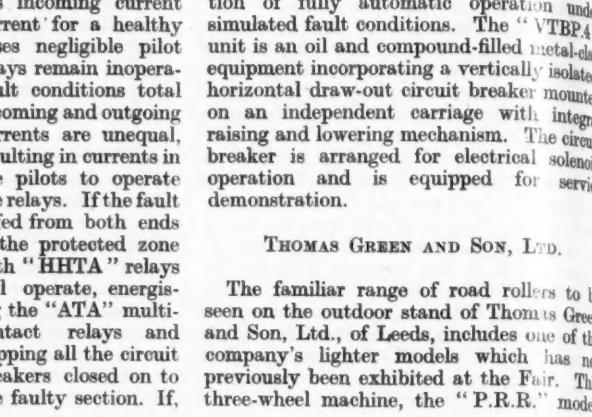


FIG. 11—PROTECTIVE SCHEME FOR RING MAIN—FERGUSON PAILIN

can be of 25 cwt or 30 cwt and is illustrated in Fig. 12.

The roller is driven by a petrol engine developing 7 b.h.p. at 1800 r.p.m., and power is transmitted through a gearbox containing forward and reverse bevel gearing and a spur reduction gear. Two speeds are available in each direction of travel and forward or reverse movement is controlled through

FIG. 12—LIGHT ROLLER—GREEN

two fabric-lined cone clutches operated through a single lever. Final drive to the rear roll axle is by a roller chain, and the boss of one of the rolls incorporates a bevel differential gear, which can be locked when necessary by a lever near the driver's seat.

The roller has a pedal-operated expanding brake on the transmission and a parking brake of the contracting band type actuated through a screw gear, which operates on a drum on the rear roll.

On its indoor stand the firm is showing,

amongst its lawn mowers, a new motor-driven verge cutter. This machine is driven by a 4½ b.h.p. B.S.A. petrol engine, with an integral reduction gear. It is controlled by a cone friction clutch, operated through a lever under one of the handle grips, and the engine governor. The rear axle is mounted on twin pneumatic tyres and the wheels are driven through enclosed spur differential gearing. The 30in wide, 10in diameter cutter cylinder driving sprocket is designed to slip under overload to minimise damage to the cutters and bottom blade when any obstruction is met. Swivelling front casters fitted with rubber tyres can be adjusted to set the cutting height of the machine.

Thomas Sadler, Sons and Co.

The tools and equipment displayed this year on the stand of Thomas Sadler, Sons and Co., Rye Mills, London Road, High Wycombe, Bucks, include examples of the company's new range of permanent magnet vee blocks. These blocks are made in two standard sizes with vee capacities of 1⅜in and 2½in, and are particularly intended for holding work of irregular shape for milling and grinding operations. When switched on, a block not only firmly grips a workpiece, but it also clings to any magnetically conductive surface. The design of these clamps is such that when they are switched on the flow of the flux is in a series of short circuits along the base of the work being held, and not from end to end as is usually the case. When reversed with the base upwards, a block can be used as a small magnetic worktable or chuck.

The photograph reproduced in Fig. 13 shows one of the new vee blocks and one of the firm's latest magnetic chucks constructed

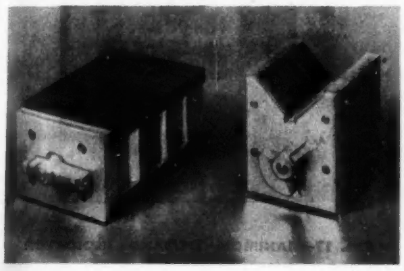


Fig. 13—Magnetic Vee Block and Chuck—Sadler

on the same principle. With this chuck work can be built up to a height of 9in, and the whole of the flux is not short circuited with the first piece of steel placed on the table.

The firm is also demonstrating a simple and effective fixture for use when truing chuck jaws, and one of its "Seastrand" surface grinding machines fitted with an inserted knife cutter for working on wood.

Ruston-Bucyrus, Ltd.

From its range of excavators Ruston Bucyrus, Ltd., Lincoln is showing the 54R.B. shovel (Fig. 14). It weighs 72½ tons and is mounted on a track, 15ft 1in long overall by 30in wide, which provides a bearing area of 64 square feet. The power unit is a Ruston diesel engine of 202 h.p. or alternatively a 125 h.p. continuous rating electric motor can be fitted. When used as a shovel the 2½ cubic yard capacity dipper is fitted to a boom, 26ft long. The machine is also available with dragline excavating equipment having boom lengths of from 60ft to 100ft.

The revolving frame is a box section steel casting with a rear extension to support the 11,700 lb counterweight. The horizontal gears are positioned in a well in the frame, which has a central boss and a transverse rib, in which the swing pinion is straddle-mounted. Conical hook rollers, used instead of the conventional centre post, are mounted on the revolving frame in four

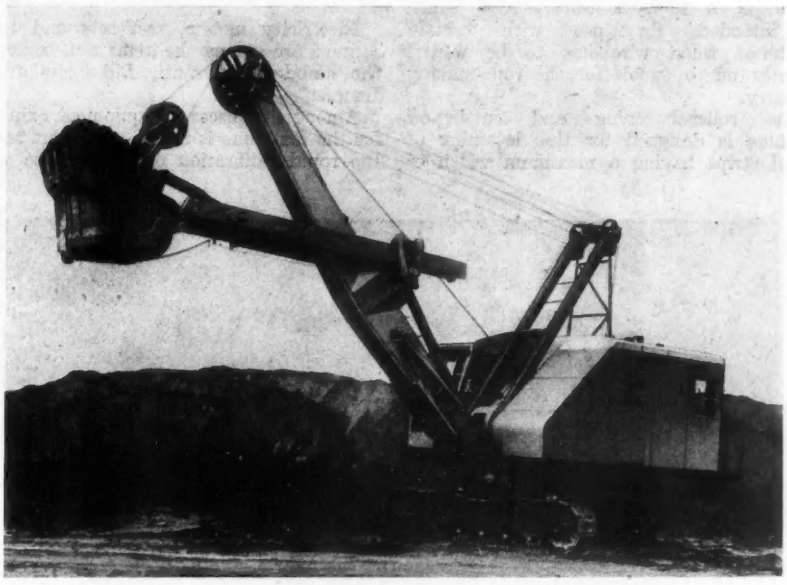


Fig. 14—54 R.B. Shovel—Ruston-Bucyrus

equalised pairs disposed at the front and rear ends.

A single steel casting of cylindrical design and having radial ribs, forming the truck frame, incorporates the bearings for the horizontal drive shaft and the swing channel rim in which the conical hook rollers ride. The rim is formed by an internal double flange path, on the back face of which is fastened, concentrically, the cast steel swing gear rack having internal machine-cut teeth. This assembly is securely bolted to the forged axles and mounted thereon are the track side frames, which on the dragline model are of composite cast steel and welded construction. The five cast steel idler lower rollers in each side frame are bronze bushed to turn on pins secured to the side frames by U bolts. The longitudinal drive is taken from the vertical shaft through bevel gears to the single horizontal shaft in the truck frame. A single chain drive at each end of this shaft connects with driving sprockets splined to the shaft carrying the double-keyed cast steel driving tumblers. Both the take up tumbler and driving tumbler shafts are mounted to slide for track tension adjustment purposes, special jacks being provided. Ground clearance under the horizontal shaft casing is 15½in. Digging pawls permit full motion in either direction or locking against movement in both directions, locking against motion to the rear only and locking against forward motion only.

Primary transmission to the transverse shaft carrying the hoist pinion and reverse clutches is by a shock absorbing multi-strand roller chain. The booster set hoist and crowd-out clutches are mounted on the main drum shaft along with the hoist and crowd brakes, all of which are of two-part construction with single-point adjustment. The 36in. diameter internal expanding swing clutches are directly hand set. A booster-set clutch is provided for raising the boom hoist and a brake for stopping, lowering and holding. An automatic ratchet and locking pawl is fitted for lowering the boom at machine speed.

The boom is of welded box section design with internal diaphragms. It is attached to the frame with a narrow foot and supported by long widespread sway braces. The handle members are of welded box section construction, 18ft long, and have welded to their rear faces the cast steel toothed racks. Crowd machinery is mounted as a single unit with a chain drive from the shipper shaft to the main machinery. Chain adjustment is not altered by boom movement. The maximum dumping radius, the boom angle being 40 deg., is 34ft at maximum dumping height.

The dipper is formed from two steel castings riveted together with a cast steel bale, on which is positioned the bale sheave frame.

When converting to dragline equipment the crowd chain, split gear, boom foot sprocket shaft and bracket assembly, crowd sprocket and the front end equipment are removed.

Sir James Farmer Norton and Co., Ltd.

In addition to wire-drawing machines, Sir James Farmer Norton and Co., Ltd., of Salford, 3, is showing one of its improved designs of roller flattening and cutting-off machines and a new bobbin winder.

One of the wire-drawing machines, the firm's "T.F.3 B," is a twenty-one die, slip, tilting-head unit for producing high-carbon, mild steel and non-ferrous metal wires at speeds up to 4000ft per minute. In this machine, illustrated in Fig. 15, the drawing cones run completely submerged in the drawing liquor to ensure perfect cooling of the wire and cones, and to lubricate the dies. The drawing cones are mounted on four spindles and the cones stepped in varying diameters to suit the drafting. A magnetic constant tension spooling device is also fitted to the machine. With this machine the main gearbox, on which the cones and dies are mounted, can be inverted to the horizontal position for threading up purposes.

A nine-block accumulation machine which is exhibited is designed for continuous drawing of all metals at speeds of up to 1500ft per

minute. On it special arrangements are provided for water cooling of blocks and dies, and the machine is adapted for drawing on spools or finishing on stationary block. A single-block wire-drawing machine shown is suitable for all purposes. It is driven by magnetic clutch, and is designed to give slow-speed starting and gradual acceleration. In conjunction with this machine there is a new bobbin winder which is intended for use with certain machines when wire has to be wound directly on to spools for the rope-making industry.

The roller-flattening and cutting-off machine is designed for the flattening of metal strips having a maximum width of 24in and a maximum thickness of ½in, and for cutting them up into predetermined straight lengths.

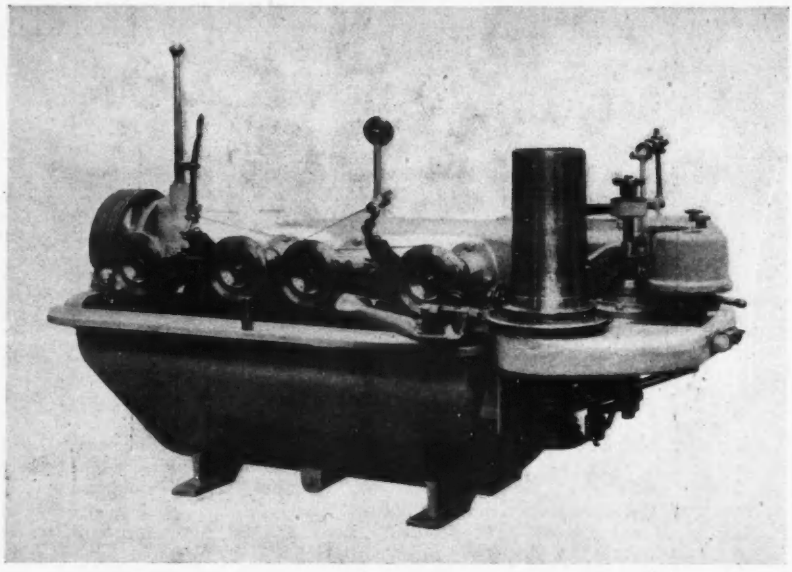


FIG. 15—WIRE DRAWING MACHINE—FARMER NORTON

The machine consists of a multi-roller flattening head through which the strip, previously in coiled form, is passed. This head is equipped with thirteen rollers, which are arranged above and below the strip and are of diminishing diameter with the largest roller at the ingoing end of the machine. The object of the diminishing diameter rollers is to enable the machine to be used efficiently on a wide range of different strip thicknesses. They are driven through special gear carried in a separate pinion box to ensure that the peripheral speed of all the rollers remains constant. The rollers run continually at the designed speed. At the exit end of the machine the strip passes through a flying shear device which cuts it up into lengths determined by a trip switch operating electrical control gear actuated by the cut end of the strip itself. After being cut the strips lie one on top of the other on a receiving table from where they can be removed in suitable stacks.

The chief feature of the modifications which have been carried out on this machine, is the complete enclosing of the levelling roller adjusting gear within the roll housings. An alteration has also been made to the flying shear motion to give better synchronisation of the cutting blades and strip as it issues from the levelling rollers.

FERRANTI, LTD.

Electricity meters, test sets and transformers are among the items represented on the stand of Ferranti, Ltd., Hollinwood, Lancs.

Among the pieces of equipment exhibited for the first time is a high-speed test set for the rapid calibration of single-phase watt-hour meters by a stroboscopic method of comparison. The object of the test set is to reduce the time involved in calibrating single-phase house service meters without foregoing the accuracy specified in B.S. 37.

The method involves comparison of the test meters against a rotating sub-standard, high-torque meter, which is never required to run at less than a quarter of its full load speed. This meter has no registers or contactors, but gives its output photo-electrically by means of beams of light shining through holes in a disc on to a light-sensitive cell.

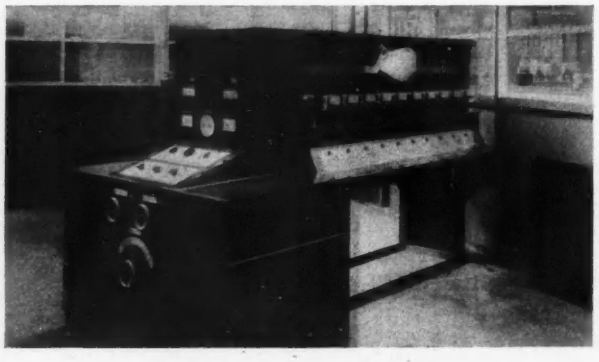


FIG. 16—ELECTRONIC TEST SET—FERRANTI

When testing meters at high loads the output of the photo-electric cell is amplified, and drives a stroboscopic lamp which illuminates the disc of the meters under [illegible] and enables their speeds to be adjusted [illegible] that they are in step with the standard which is set up for comparison. At low disc speeds this method cannot be used. The photo-electric cell output then drives a series of cyclometer counters, one for each meter under test, and they enable the meters to be timed in a similar way to the stop-watch method. The difference is that in this new method the meter under test is timed in terms of the speed of the standard so that error is given directly without calculation, and the load need not be maintained accurately.

Any meter with full-load speeds between 12 and 48 r.p.m. and carrying any stroboscopic pattern of between 100 and 200 divisions can be tested without alteration of the sub-standard. This result is achieved by using a precision decade current transformer between the meters under test and the master sub-standard, and by arranging that three separate frequencies in the ratio 4 : 1, 2 : 1 and 1 : 1 can be obtained from the sub-standard by using three sets of holes in the sub-standard disc, arranged in concentric circles of 200, 100 and 50 holes. The same arrangement is used on light load tests to cause the counters to record 1000 impulses

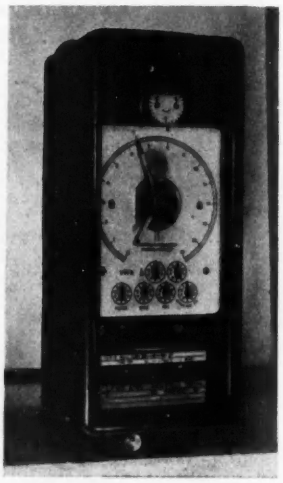


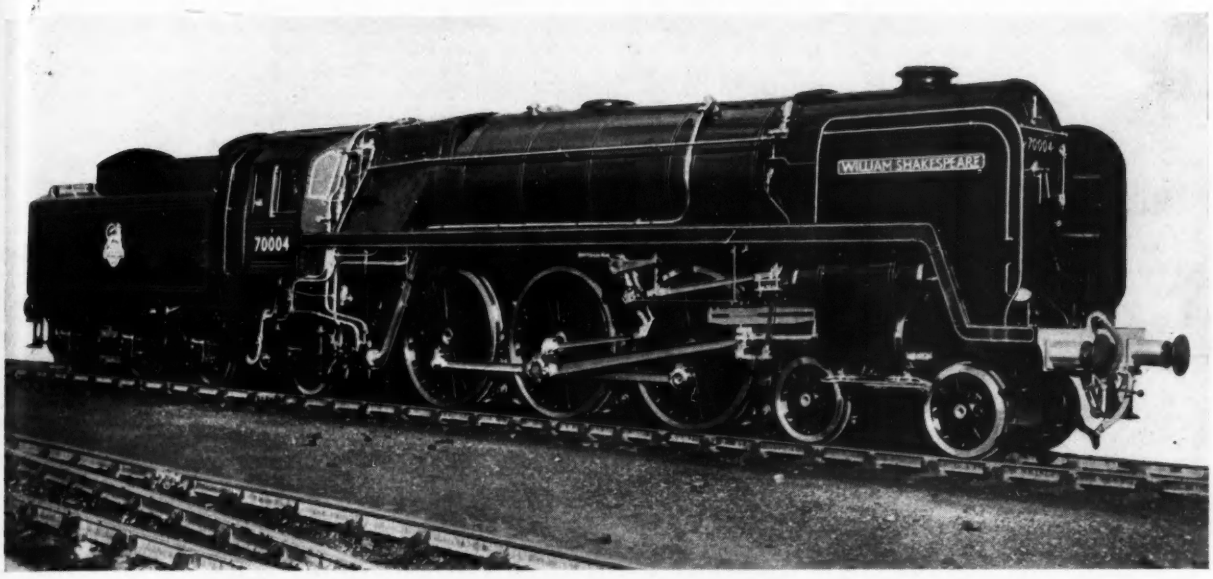
FIG. 17—MAXIMUM DEMAND INDICATOR —FERRANTI

for an integral number of revolutions of a correctly adjusted meter. The counters can also be used on full-load tests to time meters and thus measure their actual errors, either before or after adjustment by stroboscope, but this is not normally required.

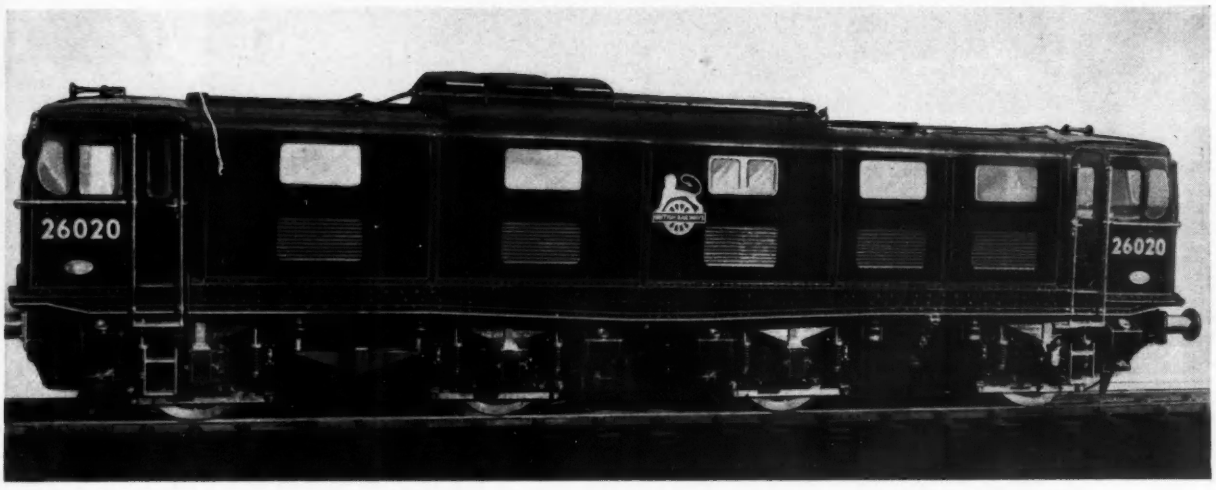
Each complete test equipment comprises a test set and up to five double-sided test benches, of which only one is being exhibited (Fig. 16). Each bench holds twenty meters (ten per side), so that the test set energises up to 100 meters, which may be calibrated by two testers. The two stroboscopic lamps are movable throughout the length of the five benches to enable the testers to place them over each meter in turn. Under each meter position is mounted a counter for testing the meter on low loads, the counter stop-start switch and an indicating lamp switched on by the tester to signify that the meter requires adjusting. The meter under test is calibrated at three points—full-load current at 1·0 and 0·5 power factor lagging, by stroboscopic illumination of its disc and at 1/20 load by the counters.

The equipment is designed for calibrating meters up to 50A capacity and of differing speeds and stroboscopic patterns by the use of one rotating sub-standard meter.

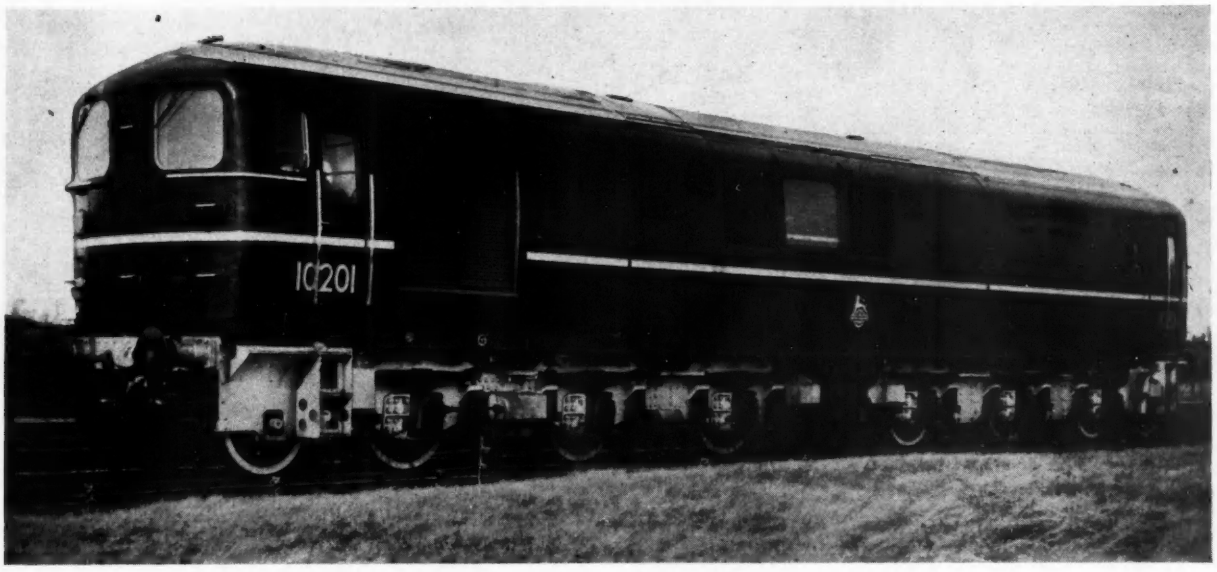
SOUTH BANK EXHIBITION—BRITISH RAILWAYS' LOCOMOTIVES



STANDARD 4-6-2 "PACIFIC" LOCOMOTIVE

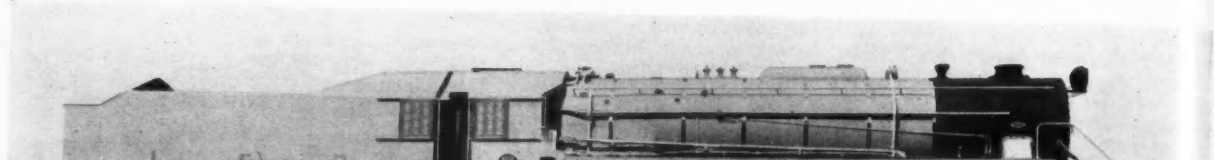


ELECTRIC LOCOMOTIVE FOR MANCHESTER–SHEFFIELD SERVICE



1,600 H.P. DIESEL-ELECTRIC LOCOMOTIVE—SOUTHERN REGION

SOUTH BANK EXHIBITION—BRITISH MAKERS' LOCOMOTIVES



"W.G." CLASS LOCOMOTIVE FOR INDIA—NORTH BRITISH

300 H.P. DIESEL MECHANICAL SHUNTING LOCOMOTIVE—STEPHENSON HAWTHORNS

660 H.P. ELECTRIC LOCOMOTIVE FOR TASMANIA—ENGLISH ELECTRIC

Another new exhibit is an impulse maximum demand indicator which is designed for operation from an "FLX" or "FLY" Ferranti meter and can be used to give remote indication of the maximum demand of the circuit that is being metered. One meter can operate several of these indicators and they can then be controlled by a time switch so that each indicator will give the maximum demand over a specified period of the day. Impulse maximum demand indicators can also be arranged to receive impulses from two meters so as to give the true maximum demand of two parallel circuits or feeders. The transmitting meters, which may be kWh, kVARh or compensated kVAh, incorporate a pair of light contacts operated by a ratchet wheel mounted on the worm wheel staff. The contacting rate can be varied by altering the number of teeth in the ratchet wheel.

The light contacts in the transmitting meter control a current in a relay in the receiving indicator. Each pulse in the relay coil drives a star wheel through one tooth and the staff of this wheel is geared by suitable ratios to the train and pointer. Reverse rotation is prevented, and a simple escapement makes it impossible for two impulses to be recorded, should the contact not make or break cleanly owing to vibration or any other cause. The actuating supply may be of any convenient voltage below about 250 and may be alternating or direct current.

For timing the resetting of the maximum demand indicator either internal or external time control may be used. In the first case a synchronous motor geared to a resetting mechanism is mounted inside the instrument and the gearbox is readily adaptable to resetting times of five, ten, fifteen, twenty, thirty or sixty minutes. Simple means are provided for setting the start of the demand period as may be necessary. When external time control is required a tripping relay is fitted and it can be excited by any external means desired which can control any number of maximum demand indicators in parallel.

The two-point instrument receives impulses from two transmitting meters and registers the summated maximum demand of both circuits and the total unit consumption.

The impulse maximum demand indicator (Fig. 17) is housed in a standard 6in or 8in instrument case which may be either round, square, flush or projecting to match any other instruments on the same panel. Alternatively, it can be mounted in a case similar to the "FLYMD" meter if it is desired to line up with other meters. The circular scale has an arc of 300 deg., divided and marked according to requirements. A central knob is provided for resetting the maximum demand pointer. In addition, dials may be provided in the lower part of the scale and they will repeat the unit reading of the transmitting meter.

Greenwood and Batley, Ltd.

In addition to a single-stage geared turbine and two typical hydraulic pumps selected from its range of products, Greenwood and Batley, Ltd., of Leeds, is showing an improved design of high-speed cold forging machine in operation.

This machine, which is illustrated in Fig. 18, is based upon the standard machine, but a number of modifications have been introduced to give a higher output. It is designed to work with wire up to ¼in diameter and runs at 300 r.p.m., which, on components requiring two blows to form the head, gives an output of 150 components per minute.

A coil of wire, usually mounted on a swift or reel stand, is fed into the machine and passes through straightening rolls, and a guide quill, to the feed rolls. These rolls, which feed the wire on alternate strokes of the machine, are driven by a friction roller feed connected to a crank disc on a secondary shaft driven by the crankshaft. After being fed into the machine the wire is cut off and a clamping transfer finger then carries it across to the heading die centre. The cut-off knife and transfer finger are operated by cams mounted on a shaft driven by bevel gearing from the main crankshaft.

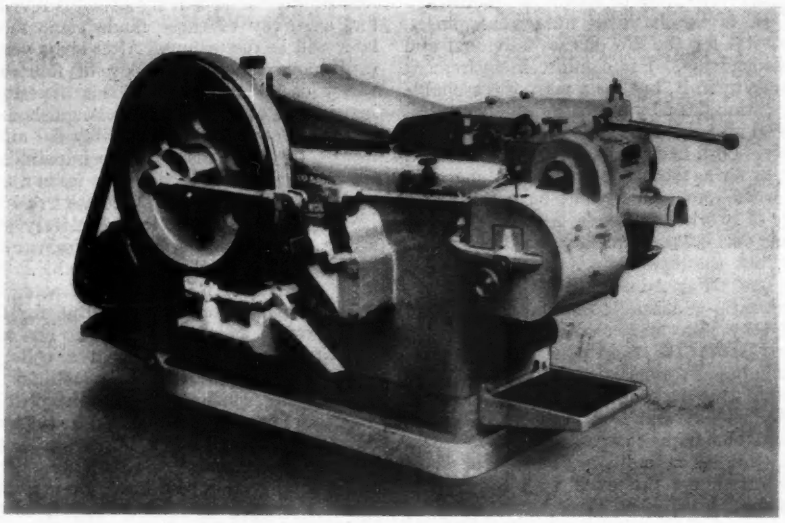


Fig. 18—High Speed Cold Forging Machine—Greenwood and Batley

The main slide carrying the punches moves forward, the wire is pushed into the die, and an upset formed by the first punch. The transfer finger is lifted and the finger and cut-off knife withdrawn as the first punch advances. In the next stroke of the slide the second punch is moved into line with the die by means of a linkage connected to the secondary shaft and finishes the head to its required shape.

The component is then ejected from the die by an ejector lever controlled by a cam mounted on the same shaft as the cut-off knife and transfer finger.

Controls and adjustments have been designed to be easy of access and operation. Lubrication is provided by a forced-feed lubricator to the important bearings and slideways. The surplus oil is collected in a sump and pumped through a filter back into the lubricator. The cut-off and transfer cams run in an oil bath.

F. E. Weatherill, Ltd.

An interesting unit for mobile mechanical handling purposes is a hydraulic loading shovel recently introduced by F. E. Weatherill, Ltd., of Union Row, London, N.17. The shovel frame is mounted on a Fordson "Major" industrial tractor and both the bucket and the arms between which it swivels are hydraulically operated. The frame is of welded heavy section channel construction with built-in pivot points for the bucket side arms and scoop control mechanism. Hinged at the highest point of the frame are the scoop side arms, which are also fabricated from heavy channel sections.

A renewable toughened steel toe plate is fitted to the scoop, which is made wide enough to sweep the track of the front wheels and help prevent the scoop from riding the heap. A hydraulically actuated mechanism enables the rate of tipping of the scoop to be controlled and can also be used to regulate the rate of discharge when handling semi-fluids. The lifting capacity of the scoop is 1 ton and it is available in sizes up to 1½ cubic yards capacity.

The hydraulic fluid is maintained at working pressure by a rotary pump connected directly to the engine crankshaft. Thrust from the main rams when actuating the scoop arms is transferred to the rear wheels and helps to increase wheel adhesion when pulling out of the heap. A relief valve in the hydraulic system prevents overloading of the bucket, and side arm movement is restricted by a diversion of fluid supply when the maximum height is reached. The side arms can be lifted to tipping height in seven seconds and lowered in five seconds, but these speeds can be reduced for particular loading conditions. Weighing 4 tons 18 cwt, the overall dimensions of the loading shovel are length, 15ft 1½in; width, 6ft 6in; height, 6ft 11in and 10ft 6in.

(To be continued)

Canadian Aluminium Expansion Programme

At the annual meeting of Aluminium, Ltd., in Montreal, Mr. N. V. Davis, the president, gave details of the new expansion programme in the Canadian aluminium industry, which is to be undertaken by the Aluminum Company of Canada, Ltd. The scheme involves a capital expenditure of 220,000,000 dollars, covering the cost of development in British Columbia, a 200,000 h.p. hydro-electric plant at Chute Savanne, on the Peribonka River in north-eastern Quebec, and the provision of new aluminium ingot facilities. In British Columbia low-cost electric power will be provided by taking water from lakes, situated 400 miles north-east of Vancouver, through a 10-mile tunnel, cut through mountains, to a power house some 2500ft below. The size of the excavation work will be sufficient for the generation of 800,000 h.p., so allowing for further expansion, and the whole scheme will take three years to complete. The Quebec programme is designed to meet current demand and is expected to commence output in one year. The combined developments at Kitimat, British Columbia, and Chute Savanne, Quebec, are expected to produce an additional 150,000 metric tons to raise the integrated Canadian production capacity to 550,000 metric tons a year. The company is already engaged in building a hydro-electric plant at Chute du Diable, on the Peribonka River, to develop 200,000 h.p. necessary for the annual production of 45,000 tons of aluminium.

The Individual in Industry

By SIR JAMES FRENCH*

WE are a community of fifty million people with a glorious past, a disturbing present and an anxious future. Of this population 30 per cent—about 14½ million—are industrially engaged in work involving the use of tools or machines or technical processes.

Work is the basis of human happiness. It is vital for the life of the individual and his dependents. His comfort in retirement depends upon it, but for a man of reasonable thrift, stimulated by a spirit of independence, it need not be an onerous essential even to-day. Lord Leverhulme, in 1916, estimated that, as far as food, shelter and clothing were concerned, our needs could be met by one hour of work per week for each person between school age and dotage. He gave no data, but the statement is unlikely to be a rash one. For Adam and Eve the Leverhulme ratio of leisure to labour was infinite until they were sentenced to a life of hard work. It is 167/1 in the case cited by Leverhulme. Among the natives of Africa, where nature is so generous, the largeness of the leisure ratio is at times the serious concern of mining companies. For our own highly organised industry, on the basis of forty-four hours per week with 3 per cent allowable absenteeism, three hours per week of overtime, and three weeks' holiday per annum, the leisure factor is 3:1. For each hour of work the individual has three of spare time. Its use is his responsibility. Unless leisure is productive, if it savours of idleness, it becomes a grave charge upon endeavour. Its purpose is restoration, not vegetation. Leisure can be made productive in many agreeable ways, by the cultivation, for instance, of other interests that add to experience.

That is why young people, seeking entry to industry, are usually asked "Have you any hobbies?"

School Education

At the beginning, and to some extent the end, of life the individual is a charge upon the care of others. Until he starts work at fifteen he is permitted to make little, if any, financial contribution to his own support, however much he might wish to do so. Thereafter, until the age of sixty-five, when he may be retired, he must earn sufficient to support himself and dependents and also to ensure some comfort in retirement and repay what he has cost others. If then he dies at seventy, his life efficiency as an independent being will be only about ⅛10 per cent. As a producer he falls far short of a machine tool upon which our civilisation has come to depend. Without such tools our complex mode of life could not be continued.

Millions are spent annually upon preliminary education. Its nature is necessarily general, for no one knows into what avenue of life a young person may wander or be directed. In one large provincial city the cost of education is three times that of any other department and four times the expenditure on housing and town improvement. Although the heavy loss on local transport is indicated with actuarial precision and may be compared with the surpluses of past years for the common good, there is no sure way of certifying what is the permanent value of the education imparted to school children, for an examination certificate is a thing of the moment, indicative perhaps only of a good memory with which time may soon play havoc.

Selection

A survey of juvenile applications made immediately after leaving school is revealing, but a survey of those made some months later will be disturbing. After eight years of continuous schooling a boy of fourteen is weary of his surroundings, his appetite for instruction of the kind has languished. In his last year he is being forcibly fed and his mental digestion may well be impaired. At twelve or thirteen the desire to learn a trade, and be paid for doing so, becomes irresistible. He discounts the advice of elderly counsellors. What his friends in industry tell him is more realistic and acceptable. Thus, after the age of thirteen school attendance should not be compulsory. But for those who show proof of talent or who can afford the time and money to gain a college or university qualification all facilities and encouragement should be amply provided, for men of special training are also necessary. Although apprenticeship, as a system, has declined regrettably in recent years, it is still a vital section of a factory organisation. From the apprentices the skilled artisans and members of staff are recruited. The system is based upon centuries of experience. Both Masters of the Guilds and their apprentices were legally bound to give and to serve for the term of seven years under the penalties of the loss of burgess rights, of fines and imprisonment until the culprit repented and made suitable amends. Without indentures no one could work within the bounds. Gradually the apprenticeship term has fallen from seven to four years, and even less for those attending a university, involving a reduction in the scope of training or more intensive instruction. Within the time available one or other—teaching or technic—must be more or less sacrificed. The advocates of comprehensive education rather than selective have gained much ground. The boundaries of apprenticeship are in sight and may disappear. Meanwhile, all who wish to become journeymen must serve an apprenticeship. Scrutiny of all applicants is necessary provided the degree of scrutiny is adjusted to suit the supply and demand. Fortunately the needs of industry are so varied few need be rejected, however backward they may appear to be. Many outstanding men have been slow and seemingly stupid at fourteen. Unless factories were so organised the supply of labour would be quite inadequate, especially in times of national emergency, involving intensive production. Probably the surest results are obtained by entrusting the selection of entrants to an elderly foreman of experience and good repute who can be relieved of some of his routine duties. Such a man, being still active, is always well informed regarding the needs of the factory. To entrust the physical examination of an applicant to a medical officer implies a standard of fitness of more importance than is necessary; for the frail, nervous man often excels as an artisan and responds more quickly.

There are many departments where even deaf and dumb people may be employed with safety. Factory records support the view that a seemingly low physical condition is no serious handicap. After deduction of redressing cases, ambulance room results, in peacetime, reach a maximum due to week-end over-exertion. They steadily fall until Friday, when there is a slight rise in anticipation of the week-end. Notifiable cases are so small in number they hardly affect the curve which appears the same week after week.

Intelligence tests and quotient classification are of doubtful value. Good material may be so easily rejected and sent elsewhere. It is an extraordinary claim that the intelligence of a young person, a complex entity, still in a fluid state of development, can be expressed by an I.Q. figure of any permanence or value, and more particularly at the time of application for a job, when fresh from school. Seeking employment for the first time is a great adventure. It is an anxious and serious occasion. Only an experienced person, of the elderly foreman type, from inside industry, sympathetic and knowledgeable, should be trusted in so important a matter, upon which the career of the young applicant depends. Selection is a field much traversed by psychologists. They have written many books and given great thought to a subject that may have later-in-life applications. However interesting the science may be the psychological classification of young fourteen-year-old people, fresh from school, carries with it psychological responsibilities, often too lightly regarded. Likes and dislikes at fourteen are transient and too unstable for any sure diagnosis of character, or even trend. Caution is essential, for upon a diagnosis the future of the young person may be the sacrifice.

Continuation Classes

Newly enrolled apprentices are expected to attend approved continuation classes. If the tuition is reminiscent of the school, then the attendance falls dismally. It continues to fall in succeeding terms. Ultimately about 20 per cent survive. Lack of interest is not surprising. The appeal of the factory in contrast with the school is too strong. Rounding up of young workers by school board officers is impossible and the giving of good attendance awards by employers is ethically questionable.

Class records and examination results, if supplemented by the opinion of a discriminating teacher, are aids to selection. They indicate, at least, determination and stamina, both qualities of importance in a factory, but are no sure criterion of ability, for success in the class room may rest only on the insecure foundation of memory rather than understanding, which is the more important. Time is the determining factor in any conflict between the calls of school education and the craftsmanship the country needs. The one can only be increased at the cost of the other. Skilled craftsmanship is the product of experience for which time and opportunity are essentials, and should not be sacrificed to further education which comes without instruction to those who have been taught to read with understanding of the value of knowledge. Apprentices have little leisure time or, indeed, inclination for continuation classes which they are expected to attend. Sometimes two hours on the evenings of three days are specified. To attend for so long is hardly possible as the following table indicates:—

	Hours
Available hours, day and night, per week... ...	168
Work hours per week (including three of overtime), less 47	121
Sleep, eight hours per night, less 56	65
Incidentals, one hour per day, less 7	58
Meals, intervals, travelling three hours per day, less 21	37
Classes, two hours on three nights per week, less 6	31
Surplus hours, per 24, for other study and recreation	4·4

This analysis shows how little spare time the apprentice has for study and revision of

* Late chairman of Barr and Stroud, Ltd.

class work and for individual reading, helpful to his daily work. It is not surprising that so few who enrol in continuation classes have the stamina to stay the course. Failure to attend regularly is not really due to indolence. It is a question of what the apprentice wishes to do with his leisure.

Choice of Trade

It will be assumed that the factory which pledges itself to give the apprentice the best possible training is of moderate capacity, that the products are of varied size and complexity, involving in some cases high precision, and that the quantities do not require a mass production organisation. There are very many factories of this kind. An apprentice well trained in such an establishment becomes a fully equipped artisan, able to find ready employment in any other factory of the kind either at home or abroad.

Character and personality, experience and ability, health and stamina, the sense or, it may be, the courage to recognise an opportunity and seize it and ambition that is not too obtrusive, rarely all found in strength in one person, are all desirable attributes that may determine success in life. But there are also negative factors that may well reduce the overall value of the life equation upon which success depends, and not all the negative qualities, even if acknowledged, are amenable to self-discipline. Chance plays a large part in the make-up of the individual, and in its distribution of virtues and vices.

There may be other good reasons for preferment. High positions are sometimes acquired, to ensure a founder family continuity, in which case the organisation, if necessary, can be reasonably adjusted, the purpose being understood. Such men may, indeed, be better qualified for the position, having been trained in the traditions of the business by the founder himself and having inherited, possibly, the combination of unusual qualities that determined success. But where reason or merit is absent the position cannot be an enviable one!

Seven years of apprentice training were required in the time of James Watt, who, however, was an unqualified artisan, having served in 1757 only one informal year with a London master. Gradually, the term has been reduced to four years and technically even less when allowance for higher education qualification is accepted as an alternative. When time was not so limited, a beginner spent some months as a messenger boy, settling down in his new surroundings, and becoming familiar with the organisation. He is now, too often, deprived of that early participation in duties that must be done by others and are so wrongly described as menial. What is more important, although not so evident to those outside industry, is that all concerned in the future of the apprentice may become acquainted with him, during the messenger stage, informally, under workshop conditions, without obtrusive examination or study. Knowing the boy, where best to start his training can then, more surely, be decided. The decision is important for much depends upon a good start.

If circumstances permitted, the beginner, hoping to become a pattern maker, would be sent to that department for the first period of the course that would comprise the principal sections of his trade. In his later years he might return to the pattern shop and finally achieve his desire to become a journeyman pattern maker. But he might not. On the results of the first period the foreman pattern maker might be reluctant to train him in a trade for which he seemed to be not fully fitted.

Frequently, by the end of his apprenticeship term, the boy himself has forgotten his earlier ambition. It may have had no more solid basis than a desire to follow his father's profession. In his progress through the shops his outlook, based on experience, may well have changed. Sir Christopher Wren was first an instrument maker and so was James Watt. Careers are serious and important things. An initial false choice may result in disillusionment, loss of valuable time and a life of regret and discontent.

Education in Schools and Workshops

To question the value of "Education," provided the word is understood to mean school education, is nowadays heretical. But children at school are not being educated; that is not the function of a teacher. They are being taught how to use the tools necessary for later study. We learn a language. It is a useful tool. We personally set out to study the language thereafter and acquire the culture of deeper understanding.

The young apprentice is just as much a learner—in Germany a "lehrling"—as the pupil at school. Tools are placed in his keeping. He is shown how to hold and use them. Progress towards skilled craftsmanship, thereafter, depends upon his own determination to become proficient in his profession. The classroom may supplement the workshop. It cannot be a substitute for it. If "experience teaches" is a wise saying, then the workshop, full of experience of so many kinds, is the best school for those whose living will be earned in industry. Solomon said, "He that walketh with wise men shall be wise—take fast hold of instruction, let her not go, keep her, for she is thy life. Wisdom is the principal thing, therefore, get wisdom and, with all thy getting, get understanding." Where can after-school wisdom be found by one destined for industry better than in the factory, in continued association with experienced men, skilled in diverse trades and engaged in the serious work of life. In such surroundings wisdom steals upon the apprentice and possesses him.

Workshop Schooling

As an alternative to external continuation classes that fail to attract and maintain attendances, workshop schooling is provided by some factories. But as competition with an education department is not the function of industry the tuition is usually closely related and wisely related to the practical work of the factory. Where the apprentice is privileged to be part of the production line, to send him to a school with its associations and implications is unwise. Solomon as a workshop manager would not have done so. Experience is a function of the number of worth-while people the individual meets. An apprentice in the workshop works with many wise men. There is only one in the school.

Small Firms and Large Ones

There is a wide range of concerns into which a young person may seek entry. Industry comprises a very large number of small firms and a comparatively small number of large ones, having extensive premises and expensive plant, with a world-wide organisation capable of undertaking contracts far beyond the capacity of the smaller establishments. As a training ground the small factory is particularly attractive. Self-reliance is sooner acquired, more is demanded of the man, there is less organisation and subdivision of operations and greater scope for initiative. Responsibility comes more quickly because it must be accepted, and with the special experience thus gained progress in the profession becomes easier.

How great in number are the small firms in comparison with the large is evident from the following *Labour Gazette* statistics of 1948:—

Group	Employed in firm	Number of firms in group	Percentage of total firms	Employees in group
(1)	10–25	15,640	30·06	274,000
(2)	25–50	12,730	25	476,000
(3)	50–100	9,710	19	728,000
(4)	100–250	7,810	15·5	1,370,000
(5)	250–500	2,920	5·7	1,095,000
(6)	500–1,000	1,330	2·6	1,000,000
(7)	1,000–2,000	590	1·16	885,000
(8)	2,000–5,000	250	0·49	875,000
(9)	5,000 and over	60	0·01	450,000
		51,040 firms		

Assuming it is the desire of every employee in a firm (it is a big assumption!) to reach the top, where there is room for only one person, then, of the 274,000 employees in group (1) of smallest firms each individual has one chance in about 17·5 of attaining that high position. Group (9), comprising the sixty large establishments, offers to each employee one chance in 5000 or more. In the intermediate group (5), the firms of which have each from 250 to 500 employees, the chance is 1 in 350 odd.

Firms originally small become larger ones, either through natural growth or by amalgamation. The repeated creation of small firms is, therefore, vital to the well-being and progress of a nation that depends so largely upon industry. What is equally important is the opportunity they provide, so widely, for the expression of initiative and ingenuity and, to those who can carry responsibility, the prospect of rapid advancement.

Ambition, not too aggressive or forceful, but in a proper setting, is a necessary quality of an executive. It is one of several characteristics, difficult to define and not always quickly recognisable. General education of a usable kind is another, but, to useful knowledge there must be added the ability to think and learn, and when necessary to think and decide quickly. Sir Isaac Newton, when asked how he discovered the law of gravitation, was it by the fall of an apple, replied, "By thinking, thinking and thinking." It was purposeful thinking, not dreaming. At nineteen he was a graduate of Trinity College, Cambridge. By contrast, Michael Faraday, patron saint of our electrical industry, was a bookseller's messenger boy at thirteen, laboratory boy at twenty-one, and at twenty-three was still regarded by Lady Davy as valet to her husband.

Academics and Advancement

However helpful and self-satisfying higher education may be, it does not in itself determine promotion in industry. It is true there is a natural tendency to favour the academically qualified candidate for a staff position, but as a survey of the careers of those who hold the more important positions in industry would indicate, there must be other qualities of importance. They are the same qualities that determine the value of an apprentice raised to a greater degree. Of young graduates who enter a large workshop not 30 per cent reach prominent positions. Even lower estimates have been given. Graduates fresh from college on entering industry at once come into competition with men of equal age already well advanced technically and not so devoid of learning as is often assumed. Until a graduate has gained some practical experience there is little opportunity of using his academic advantage.

If he has no workshop experience he has little chance of entering the drawing-office, on merit, in competition with the best apprentices who strive to gain experience in that important department from which men are often selected to fill higher executive positions. There is no gainsaying the value of the universities, provided they concentrate their teaching upon fundamentals, experiments in demonstration of these principles and long-range research. Colleges, rightly termed technical, should then concern themselves with the applications of principles, short-range research and in due course the development of fundamental research results. Unfortunately, universities are being constrained to extend into the "suburbs" of education.

Whether or not the academic training should precede practice is a debatable question. It is not easy for a graduate to descend from the university altitude to the low level of a first-year apprentice whose duties savour of the menial, but are none the less essential. In the mind of the potential works manager there should be no vacant spaces where shop duties are concerned. Academically, the graduate is older than his shop mates, technically he is younger and has much to learn. But he need not seek far, because all the tools around him are the repository of first principles. But some preliminary understanding of their use and application is a first essential for their location, examination and interpretation. Reversal of the system, the serving of the apprenticeship before taking the degree, has also disadvantages. Workshop practice is never static. When he returns he will have much to learn that his competitors have naturally absorbed during his four years of absence.

There is an intermediate "sandwich" system now well established, particularly in Scotland, where it is especially favoured. The colleges and universities legislate, specially, to suit the engineering students who then receive their academic training during the winter months and workshop instruction in summer. Although not a perfect system it goes far to overcome the disadvantages of the other extreme systems. It is possible then to obtain the degree and complete the apprenticeship in the same year, thus securing the great advantage of continuity. Industry would benefit if the first year was spent wholly in the college (classes during the winter and laboratories in summer), and the subsequent years in the college and workshop under the sandwich system, with a final year wholly in the workshop. It is undesirable to sacrifice practice to precept as is sometimes done.

Foundations of Industry

Throughout the complex structure known as industry there are many opportunities for advancement in diverse directions and varied degrees, and provided the individual is not physically and mentally incapacitated there is always some position into which he can and must be usefully fitted. But unfortunately national emergencies, direction of labour and full employment have now made impossible the rigid selection of employees for the purpose of maintaining the good character of the personnel.

Contentment, modest ambition and ability amongst its personnel are the foundations of industry. From the labourer the qualities required are physical strength, robust health, endurance and experience. Having little superior education he expects little and holds the bottom of the ladder others climb. He does so willingly. If offered the position of gaffer, he would probably refuse, being a realist who knows what management demands and what he has not got. But labouring is not wholly an unskilled job. Lord Kelvin, the industrialist and consulting engineer, when engaged on a boiler test, for example, would listen with eagerness to the exposition, by the stoker entrusted with the job, of the principles underlying heat transference and complete combustion, with chimney top demonstration. He had less to learn from the young graduate who had not yet acquired the unconventional experience few have the opportunity of gaining. Youth at the helm is safe enough practice, provided there is an experienced officer on the bridge with a still more experienced captain within call. But youth, except as the brilliant exception, cannot by-pass the experience that comes to all through long earnest work. Even when the term was seven years the apprentice entered the improver stage, of indefinite duration, until he could claim to be a skilled artisan. "Science in Industry" as a slogan implies ignorance of its value by industrialists. It is only necessary to consider the immense achievements of industry in order to refute the charge that it takes too little interest in science. Industry is, indeed, built on science, much of which originates in the workshop. Nevertheless, a young graduate equipped only with a degree is of little use in industry, being only half educated, lacking the complementary practical experience.

Considering the ever-increasing complexity of industry and the great variety of work to be undertaken in any one factory, versatility is an essential quality, and particularly so in the drawing-office and short-range research departments, where science and practice are inseparable qualities, and where the faculty of quick thinking and decision must be well developed. Occasions do arise when speed of action is imperative, and where there is little time for pondering or seeking information from others than those engaged on the job. For factories are organisations for the fulfilment of contracts within a limited time, sometimes under penalty, and the terms of a rigid specification. But there are few industrial firms of importance that are not engaged upon development work, producing new materials or new effects by new means. It is, in fact, only by the exercise of its accumulated and varied experience, its ingenuity, resourcefulness and facilities that a firm can maintain its position. Its experimenters and designers are pioneers working in the van of progress. All technical books and published papers are historical; they deal with what has been already done. Even patent specifications that seem to illuminate the way are out of date. Those who work in industry, but in advance of production, must be self-reliant and self-contained, qualities that are not too common. There are few whom they may consult. The pioneers of industry spend their lives hunting in unknown jungles, for which there are no guide books until they themselves may write them.

Cold Cathode Lighting in a Railway Coach

Shortly after the war several passenger coaches on British main lines were equipped with fluorescent lighting using 2ft hot-cathode lamps. An alternative fluorescent lighting system is to employ cold cathode tubes, which have certain advantages for railway applications and have been adopted to some extent overseas for this purpose. In conjunction with the London Midland Region of British Railways, the General Electric Company, Ltd., undertook the development of a cold cathode installation suitable for coaches with the standard British 24V, d.c. lighting system, and the first vehicle equipped in this way went into traffic between St. Pancras and Derby on April 23rd.

The coach in which the new lighting has been installed is a first-class restaurant car of the London Midland Region. In a vehicle of this kind the colour rendering quality of the lighting is of special importance. In a cold cathode installation "gold" colour tubes can be combined with "white," to impart a warm tone comparable with the effect given by the red rays emitted by tungsten lighting. Since the first fluorescent lighting installations were made in British rolling stock, new hot cathode fluorescent lamp colours have been developed which compensate for the deficiency of red light from the earlier lamps. Cold cathode tubes, however, have a further advantage, for

Cold Cathode Lighting in Restaurant Car

rolling stock installations, of long life. The life of the tubes should extend over four years' coach service, so that replacement should be required only during the major overhaul.

The new restaurant car lighting had to be planned within the capacity of the existing 24V, d.c. carriage installation. A motor alternator set to provide a suitable supply for the cold cathode tubes was developed by the Electro Dynamic Construction Company, Ltd. The machine has stable voltage output characteristics under the different input terminal voltage conditions encountered when the battery is charged or discharged. This result has been achieved entirely by the electrical design of the machine and no voltage regulator is used. The a.c. output from the machine is 110V, 400 c/s, a frequency which has already been widely adopted for fluorescent lighting in transport vehicles and aircraft, since it enables small and lightweight transformers and capacitors to be used in the lamp circuits.

The cold cathode tubes are mounted in a continuous triple row along the centre of the ceiling the two outer tubes being "warm white" and the centre ones "gold." They are contained in fittings 31ft long in the smoking compartment and 13ft 6in long in the non-smoker. Each fitting consists of a sectionalised reeded "Perspex" enclosure, (as illustrated herewith) with satin silver decorative end pieces, and covers of similar material and finish at the junctions of the "Perspex" sections. Two lengths of cold cathode tubing are employed, 7ft 10in in the smoker and 6ft 10in in the non-smoker. The transformers, one for each tube, are installed between the ceiling and the roof of the coach.

Any tube can be removed by taking off the corresponding section of the "Perspex" enclosure. Interlocks incorporated with the covers ensure that the supply is cut off before access to the tubes is possible. The switching arrangements enable half illumination to be used, during maintenance periods.

The Royal Ordnance Factory at Wigan

DURING the course of a brief visit to the Royal Ordnance Factory, Wigan, we were able to see the production of the 20-pounder shell as used particularly with the "Centurion" tank. This establishment commenced with the production of 25-pounder shells in June, 1940, and was later to handle some 600 tons of steel per week. After the war the plant became partly engaged on "civil" work, which took the form of motor and generator stator winding. It was later apparent, however, that if the factory was to remain in commission for arms manufacture, it would be necessary to undertake a greater variety of work. Accordingly, some of the 25-pounder plant was replaced by heavier plant capable of handling shells within the 5in to 6in range, and a scheme was introduced for the reorganisation of the whole factory, the object being to enable it to tackle a wide range of projectiles concurrently. Finally, it was decided to introduce "controlled inspection" and handle the work on conveyors, thus ensuring that each component automatically traversed a fixed route, and was examined at specified points. The scheme is now about 80 per cent completed and has resulted in an increase in productivity of about 20 per cent.

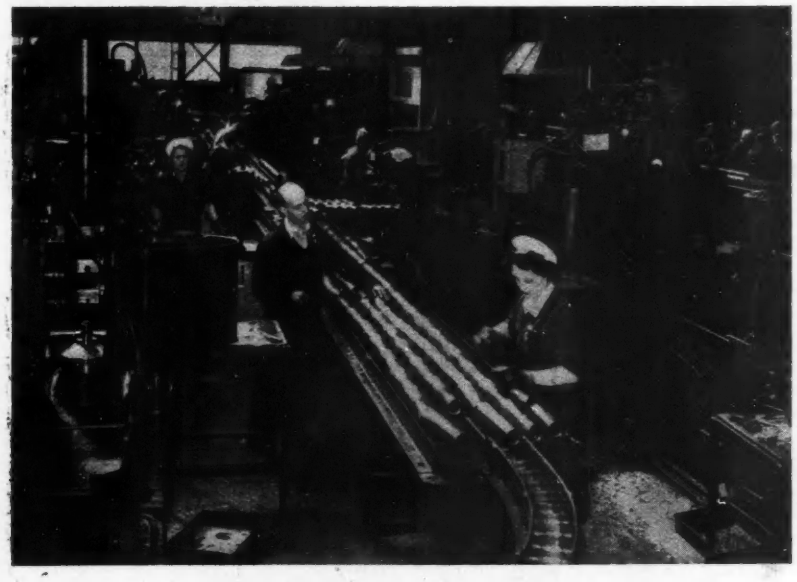
FURNACE AND FIRST FORGING OPERATION

A considerable portion of the machine shop is engaged upon the manufacture of shells of larger calibre, but the processes are, in general, similar to those for the 20-pounder production line, which we were able to follow from the entry of the billets to the despatch of the shell to the filling factory.

150-TON VERTICAL HYDRAULIC PRESS

The 3½in square billets from which the shell blanks are cut are of a 0·4 per cent carbon steel with high manganese content, of 19 tons tensile, which is stated to be about twice as tough as the steel formerly used. Billet lengths are delivered direct from a rail head to the cutting section, where they are partly burnt and then parted by a 70-ton hydraulic shearing machine into lengths forming the shell blanks, which then pass on roller conveyors to a coal-fired furnace. A hydraulic ram slowly feeds the continuous line of blanks through the furnace, during the traverse of which they attain a temperature of about 1000 deg. Cent. There then follow three forging operations in quick succession and without reheating. In the first of these operations the blanks are squeezed to the required diagonal size, as is shown in our illustration. This operation also assists the blank alignment during the next process—that of piercing the shell core, on a vertical hydraulic press. The core is obtained by a single vertical displacement of the die under a pressure of 150 tons per square inch, and the capacity of a single machine appeared to be about six blanks per minute. Three such punches are attached to an indexing head on the ram and by their alternate use on succeeding blanks the temperature of the dies, which have a 10 per cent tungsten content, is kept within required limits, and an overall life of about 700 pressings is obtained. This forging press is illustrated herewith. For the larger shells, however, a single water-cooled punch is employed. Using telpher manipulating equipment the shell blanks are passed quickly to a horizontal mechanical draw press. The principal motion in this process is effected by a reciprocating ram worked from a 75 h.p. engine, and during the forward displacement of the ram both the blank and the internal mandrel on which it is first mounted are forced forward at differential rates through draw-roller dies, imparting to the shell the required length, diameters and base wall thickness. Each blank at this point is checked for concentricity and is then despatched to the machine shop on a conveyor moving slowly at a rate adjusted to suit shop requirements. It cools to atmosphere during this transfer and can normally be handled on arrival at the centre-drilling machines. The blanks are then sawn to length and pass to adjacent batteries of Churchill multi-tool lathes for rough external machining; the core is not machined. There is a further inspection of all shells at this stage.

For the "bottling" operation, whereby the shell receives its nose taper, the blanks are reheated to 850 deg. Cent. and passed to a smaller vertical hydraulic press from where they are stacked to cool. After this operation the shells proceed along a fresh line composed of Kitson "C" and Ryder machines which bore the fuse hole, finish turn the body, and radius the neck formed by the fuse hole and the core. The spigot is also removed, the blanks pass to a Malcus centreless grinder and are then weighed. The extent to which a shell may exceed standard is marked on the shell by a code number, and the blank proceeds



20-POUNDER SHELLS AFTER "BOTTLING"

to a Kitson "D" lathe incorporating a special indexing wheel which when set to register the particular weight code number presets the depth to which metal is recessed from the shell base. In this locality of the line the driving band groove is machined and the copper driving band pressed on. A base plate which fits into the recess of the shell base is fixed into position by cold hammering along the periphery in a Flowers riveting machine. This recess disc is a precaution against failure of the shell base causing an explosion in the gun barrel. Integral with the disc is a tracer boss to which is fitted, eventually, a device for plotting shell trajectories. The shell base is again turned and the tracer boss thread milled. Forming and turning the driving band is the last operation before the shells undergo their final inspection. Particular importance is attached to the degree of eccentricity of the shell about its polar axis as this condition adversely affects the sensitive mechanism of the fuse. Although the core is not machined, a tolerance of only 12 thousandths of an inch is allowed on the annulus at any cross section.

The processes of shot blasting, painting and varnishing are completed before the fuse hole is thread milled in order to prevent fouling of the threads.

Tungsten-carbide tools are used in most of the machining operations. In the production line, however, are a few machines which are regarded as out of date, and the establishment has been aiming at their early replacement. It is intended that the plant should be able to provide forged blanks to several other satellite works. The forging capacity of this establishment is noticeably greater than are the requirements of the machine shop.

Standard 4-6-0 Mixed Traffic Locomotive

THE first of the new 4–6–0, Class 5, standard mixed traffic locomotives for British Railways was recently completed at the Derby Works. These engines are the second of the six standard classes which are to be introduced by British Railways this year and have been designed and built under the direction of Mr. R. A. Riddles, the Railway Executive member for mechanical and electrical engineering. The Doncaster drawing offices have been mainly responsible for the design, although Brighton, Derby and Swindon have been concerned with certain sections.

The first of the new engines, No. 73,000, is illustrated on this page and its leading dimensions are as follows :—

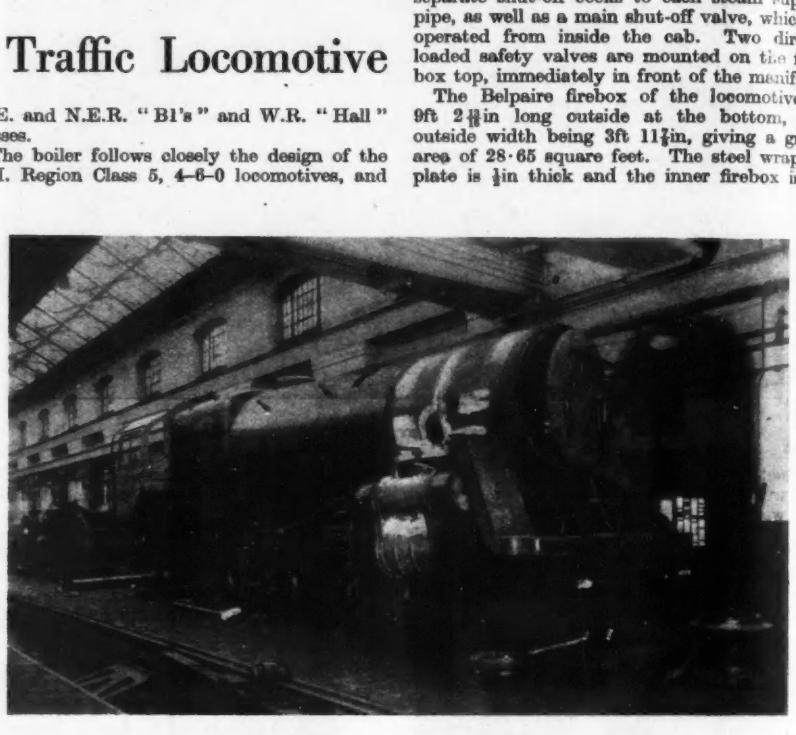
Cylinders (two), dia. and stroke	19in by 28in stroke
Wheels, coupled dia.	6ft 2in
Wheels, front bogie, dia. ...	3ft 0in
Wheelbase, coupled	15ft 6in
Wheelbase, engine	27ft 3in
Heating surface :	
Tubes	1,479 square feet
Firebox	171 square feet
Total evaporative	1,650 square feet
Superheater	369 square feet
Grate area	28·65 square feet
Boiler pressure	225 lb per square inch
Tractive effort	26,120 lb
Adhesion factor	4·97
Weight of engine in working order	76 tons 0 cwt
Weight of tender in working order	47 tons 4 cwt

Many features and details of the design of the new class are common with those of the first Class 7 standard locomotives, which were fully described in our issues of February 2nd and 9th. The new engines are intended for similar duties to those at present carried out by L.M.R. Class 5, E. and N.E.R. "B1's" and W.R. "Hall" classes.

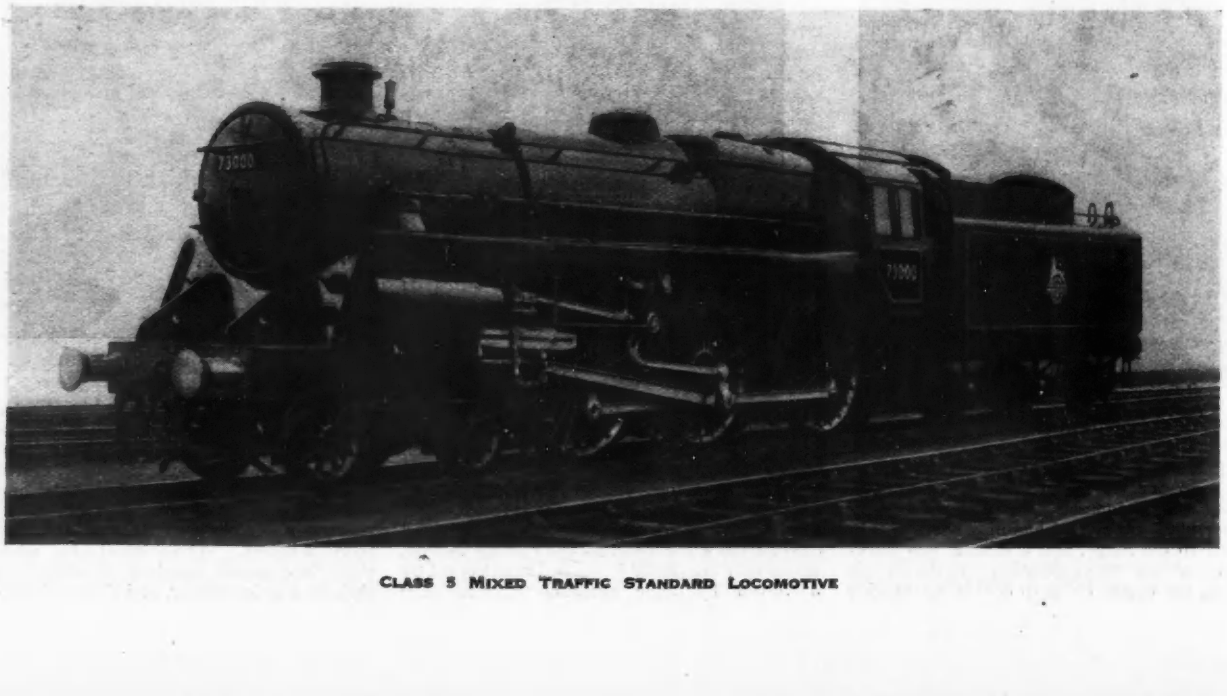
The boiler follows closely the design of the L.M. Region Class 5, 4–6–0 locomotives, and the same flanged plates are common to both, as is the working pressure of 225 lb per square inch. The shell is of high tensile carbon manganese steel and the barrel consists of two rings, rolled from $^{17}/_{32}$in thick and $^{19}/_{32}$in thick plates, respectively, the outside diameters being 4ft 11 $\frac{11}{16}$in at the front and 5ft 8$\frac{1}{4}$in at the firebox end. There are twenty-eight large flue-tubes, 5$\frac{1}{8}$in outside diameter, and 151 small tubes, 1$\frac{3}{4}$in outside diameter, the length between tubeplates being 13ft 2$\frac{7}{8}$in.

A vertical grid regulator in the dome is operated by an external pull-rod connected to a transverse shaft, which works through a stuffing-box on the second barrel plate. The boiler is fed with water through two separate clack valves placed at approximately 30 deg. on each side of the vertical centre-line of the front barrel. These valves deliver on to two inclined trays, which deflect the incoming water round the inside of the barrel clear of the tubes. A steam manifold fitted on the firebox top, in front of the cab, is provided with separate shut-off cocks to each steam supply pipe, as well as a main shut-off valve, which is operated from inside the cab. Two direct-loaded safety valves are mounted on the firebox top, immediately in front of the manifold.

The Belpaire firebox of the locomotive is 9ft 2$\frac{13}{16}$in long outside at the bottom, the outside width being 3ft 11$\frac{1}{4}$in, giving a grate area of 28·65 square feet. The steel wrapper plate is $\frac{1}{2}$in thick and the inner firebox is of copper, with a $\frac{1}{2}$in thick wrapper plate. The firebox has a forward sloping throat-plate and its tubeplate is 1in thick. All firebox



ENGINE UNDER CONSTRUCTION



CLASS 5 MIXED TRAFFIC STANDARD LOCOMOTIVE

water space stays are made of Monel metal and are fitted with steel nuts inside the firebox, the roof, longitudinal and transverse stays being made of steel.

A rocking grate is built in eight rocking sections, each section carrying fourteen renewable firebar units, making a total of 112 units for the whole grate. The grate is divided into two parts, front and back, and each part can be rocked separately from the footplate, the operating gear being so arranged that two different travels can be employed. A full travel is used for dropping the fire when the engine is over an ashpit and a shorter travel for agitating the fire to eliminate ash and break up clinker while the engine is on the road.

The bottom flap doors of the self-emptying, three-hopper ashpan are operated by a hand lever from ground level. The front and back damper doors are separately opened and closed by means of screw gear worked by handwheels.

The cylindrical smokebox rests on a fabricated saddle. The blower ring is incorporated in the blast pipe, which has a plain circular cap of 5⅜in nozzle diameter. In the self-cleaning smokebox, plates and a wire mesh grid are arranged to prevent accumulation of ash in the bottom of the smokebox when the engine is working.

Some photographs, which we reproduce, of the locomotive in course of construction, give an impression of the frame, cylinders and valve gear at an intermediate stage of erection.

The main frames, of 1½in thick plates, are spaced 4ft 1½in . part and are well braced by horizontal and vertical stretchers and by pin-jointed cross stays attached to the axlebox guides. These guides are fitted with manganese steel liners on the wearing surfaces. The dragbox at the hind end is fabricated and a single drawbar transmits the tractive effort to the tender through rubber springs. Brackets integral with the dragbox support the boiler at the hind end of the firebox and no expansion angles of the usual type are required. Side footplating is carried by brackets fixed to the smokebox and boiler.

As with the Class 7 locomotives, the engine and tender are carried throughout on Timken roller bearing axleboxes, those for the bogie and coupled axles being of the non-split cannon type. The faces of the axleboxes in contact with the guides have manganese steel liners welded to the body of the axlebox. Underhung spring brackets with rubber damping pads and links in tension are provided for the coupled axle springs, which have a span of 4ft when loaded.

The two cast iron outside cylinders have 11in diameter piston valves with a steam lap of 1 1/16in and a lead of ¼in. Conventional Walschaerts valve gear gives a travel in full gear of 7⅛in and a full gear cut off of 77·5 per cent. The slidebars are of the three-bar type, with underhung crosshead. A bronze spring-loaded slipper in the piston head carries it clear of the cylinder barrel.

Lubrication of motion pins is by grease nipple and gun: those for the reversing shaft and expansion link being grouped together on the motion bracket. The eccentric rod big-end runs on a Skefko self-aligning ball bearing. Valve and cylinder lubrication is by atomised oil delivered by mechanical lubricators. Large steam-operated cylinder cocks are fitted for quick draining of the cylinders. The same kind of reversing gear is used as on the Class 7 locomotive, namely, a reversing screw and nut acting directly on the reversing shaft arm, actuated by means of a tubular shaft from a handwheel, which occupies an end-on position in the cab. A drum-type cut-off indicator is provided.

The tyres are shrunk on the coupled wheels and secured by two small lips, one each side of the wheel centre, there being no separate ring, studs or rivets. Built-up weights in the wheels balance the revolving and 50 per cent of the reciprocating weight.

The bogie is identical with that fitted to the 4-6-2 engines in the standard series and has non-split cannon Timken roller bearings. The engine weight is carried by side bolsters and laminated springs fitted in compensating beams. Side play control of the bogie is by means of double coil springs.

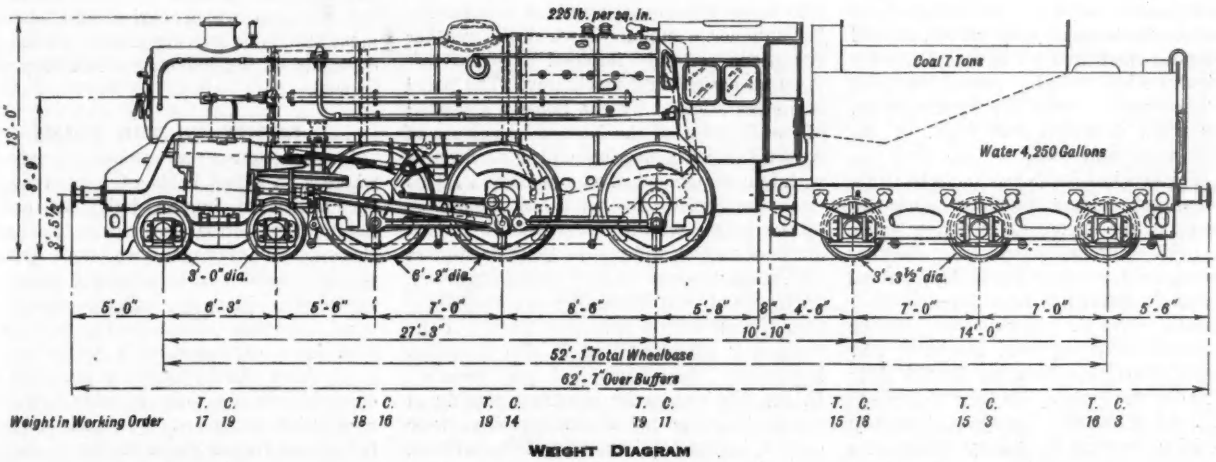
The cab arrangement follows exactly the lay-out approved for all the standard engines. Its structure is carried by brackets from the main frames, with a cantilever extension backwards to the tender front plate, dispensing with the usual hinged fall plate. An exhaust and live steam injector are both carried on the right-hand side of the engine under the cab and all steam and water controls for both injectors are operated from the fireman's side of the engine.

All of the cab driving controls are grouped to give easy access and operation, the vacuum brake, sanding and blower valves being carried on a control column at the driver's right hand.

The tender is also the same as that used for the other standard locomotives. Its fabricated tank has a large radius at the corners to facilitate welding of the plates, and the coal bunker, which is rectangular, is narrower than the tank. Two external feed water sieve boxes are provided to collect dirt and foreign matter from the water before it passes to the injectors, the sieve being easily withdrawn for cleaning or renewal purposes. Water pick-up gear is provided. Roller bearing axleboxes on the tender axles are fitted on to journals outside the wheels.

Both engine and tender are equipped with steam brakes, which can be worked independently or in conjunction with the vacuum brake by a separate driver's valve. Single brake blocks apply on the six coupled engine wheels and all tender wheels.

REAR END OF ENGINE UNDER CONSTRUCTION



WEIGHT DIAGRAM

COMMERCIAL CONDITIONS IN THE SUDAN.—A review of commercial conditions in the Sudan has been published by H.M. Stationery Office, price one shilling. It is the latest volume in a series prepared by the commercial relations and exports department of the Board of Trade.

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FOUR ART PLATES—SOUTH BANK EXHIBITION

AGRICULTURAL MACHINERY TRIALS

TRIALS of any new machine, carried out by an independent authority under normal working conditions, are always of value to designers and manufacturers. They are the best means of establishing if the machine is capable of doing effectively the job for which it has been produced, they help to reveal any weak points in its make-up, and they give an indication of improvements or refinements that might usefully be made. Nowhere, perhaps, is that to be seen more clearly than in field trials of agricultural machinery, for that class of machinery is required to work under very varied, as well as strenuous conditions. The mechanisation of agriculture has probably caused engineers more "headaches" than the mechanisation of any other industry, but much of the progress made and many of the successes which engineers have achieved in mechanising this country's oldest industry must be attributed to the lessons derived from trials in the field. Throughout its long and distinguished existence, the Royal Agricultural Society of England has regularly organised such trials. Over the last hundred years or more, many different farm machines and implements have thus been put through their paces under the careful scrutiny of farmers as well as of engineers. The spirit of healthy competition amongst machinery makers has been engendered; designers have been encouraged, and the efficiency—or sometimes inefficiency—of their products has been proved.

The most recent trials to be arranged by the Royal Agricultural Society were held last year and attracted a good deal of attention from engineers and farmers. They were concerned with forage machinery, an important development in mechanised agriculture in view of the great changes which have taken place in dealing with grass and other green crops in order to provide as large a quantity of high-protein cattle food as possible. These trials were the essential part of a competition for British forage-handling machinery which was divided into three classes as follows—machines in or ready for manufacture for the collection of hay and straw from the windrow; machines for the collection and disposal of green crops for silage or artificial drying, and prototype machines for any purpose directly connected with the collection or disposal of hay, straw and green crops. In the three classes twenty-seven British machines were presented for trial. They included pick-up balers and loaders and cutter-chopper-loaders; some were already quite well known in the farming industry, while others, of course, were making their first appearance. The trials were carried out in Oxfordshire last summer, a summer in which the weather conditions certainly imposed a severe test upon all agricultural machinery. The panel of judges selected by the Society consisted of the Director of the National Institute of Agricultural Engineering and four farmers with long experience of mechanisation. This week the Society has published the report of the judges on the competition. It is a document which will undoubtedly be studied with much interest by agricultural engineers, for it not only emphasises the careful arrangements made for the adequate testing of the competing machines, but it also compares impartially their individual performances. In the two classes for machines already in production, the main considerations were output, labour requirement and capital cost, account also being taken of adaptability to varying crops and circumstances. One rule for these classes was that entries were liable to disqualification if they failed to start work within half an hour of the appointed time, or if, through mechanical breakdown or similar cause, they afterwards stopped work for a total period exceeding one hour. It is recognised that British agricultural machinery makers pay careful attention to the quality of their products, but it is nevertheless pleasant to read in the report that, during the trials of the production class machines, no breakdowns of any consequence occurred. Nothing is more likely to exhaust a farmer's patience and endanger the good relations that now exist between him and the engineer than a machine which quickly develops mechanical faults! In the prototype class, the judges looked mainly for machines which might be developed to fulfil farming needs not already met by machines in production, and they therefore wisely attached no great importance to the completion of trials without mechanical breakdown. In fact, in one instance, they made an award to a machine which failed to work at all during the trial period! They did not ignore its future possibilities.

In organising this competition, the Royal Agricultural Society has once more demonstrated its determination to pursue its original aims, one of which was "to encourage men of science to the improvement of agricultural implements." The enthusiasm shown for the competition is another sign of the British agricultural machinery industry's anxiety to provide the best implements that can be devised for every aspect of modern farming practice. The lessons to be learned from the forage-handling machinery competition—and there are many—will, we feel sure, not pass unheeded by engineers. There is one, in particular, which appears to us to merit special consideration. It is contained in a comment by the judges that some of the machines did not offer "enough advantage to offset their higher cost and greater complication." With rising prices of raw materials, it is indeed difficult to-day for agricultural engineers to restrain their production costs from mounting. Farmers, however, in this country and overseas are not easily attracted by high-priced machinery. Nor are they anxious to master the intricacies of highly complicated mechanisms. Improved production methods and greater simplicity in design are the ends to which agricultural engineers must always be striving in order to meet the demands of the industry which they serve so well.

SAFETY ON THE ROADS

IT seems to us a very curious anomaly that, whereas in other fields of human activity the frailty of human judgment and its liability to error is widely recognised, there are still very many who hope by multiplying penalties and increasing police surveillance to reduce the high rate of accidents upon the roads. Even Government spokesmen have expressed such opinions. Yet surely they should know better. For such opinions are not only at odds with those repeatedly expressed by road engineers, but also at variance with the results obtained by the researches of such bodies as the Government-supported Road Research Laboratory itself. Moreover, it has long been recognised in other fields of human activity that though propaganda can undoubtedly contribute to safety, pains and penalties for the "criminals" who cause accidents serve very little purpose. If the number of accidents is to be reduced, in fact, measures more positive in effect than appeals and threats must be adopted.

On the railways, as is well known, accidents become the subjects of Inspecting Officers' inquiries. Almost always, directly or indirectly, some individual—a signalman, a driver, a porter, or a platelayer perhaps—

can be found at fault. But the purpose of the reports is less to lay blame upon the man than to suggest means whereby any similar accident can be prevented from occurring in the future. Recommendations are therefore usually made for the improved interlocking of signals, improved equipment or improved maintenance, &c., designed to mitigate the consequences of any future failure of human judgment. As the direct consequence of the application of such measures over many years, and despite the fact that trains must be operated and controlled by fallible men and women, the railways of this country have built up for themselves, through the ingenuity of engineers, an unrivalled reputation for safety. Again, in progressive factories the attitude of managements to accidents is similar. Every accident is the subject of a report. Their causes almost without exception are found to lie in some failure of human judgment. But it has been found possible to reduce their number by covering up dangerous running parts and devising ingenious guards for press tools and other machines, &c. The man concerned is, of course, blamed, but means are earnestly sought which will positively prevent the recurrence of an accident even should human judgment fail once more. In the air and at sea it is less easy to devise systems or mechanisms that will positively prevent disasters. But through the improvement of equipment and the development of new devices, such as "radar," the judgments that pilots and captains are called upon to make are simplified and the chance of error thereby reduced. Only upon the road does there seem to exist any substantial body of opinion that holds, not only that road users are primarily to blame for accidents—an obvious truth—but also that those who cause them are necessarily unusually careless or reckless or incompetent. That opinion, we are convinced, is erroneous. For do we not all at times do careless and reckless things? Is there anyone who can, with his hand upon his heart, swear that he has never stepped carelessly off a pavement, never "cut in" because he misjudged the speed of an approaching vehicle, never overtaken another vehicle on or too near a corner, never been at fault? The fact, recognised almost universally elsewhere than on the roads, is that human beings cannot be consistently careful, consistently attentive, consistently correct in judgment. It follows, as road engineers repeatedly point out, that if accidents upon the roads are to be reduced in number, then the opportunities for human misjudgment upon them should be reduced and the consequences of momentary carelessness or inattention made less severe. In short, the roads must be easier and safer to drive upon.

Ideally, of course, at least all main roads should have twin tracks, all main road crossings should take the clover leaf form, sight lines everywhere, on curves and over the brows of hills, should be long, all curves should be super-elevated and the like. Ideally, too, city streets should be liberally equipped with guard rails and over and under passes should be provided for pedestrians. But in the straitened economic situation of this country the cost rules that ideal solution out of court. Must we then accept that as traffic increases road accidents too must rise in number? We do not think so. For, to bring about a substantial reduction in the accident rate on the roads, it is unnecessary to go to such great expense. In other forms of transport an inquiry is held into every accident. When similar inquiries are made into road accidents it is nearly always found that some defect in the construction or lay-out of the road contributed to the accident. Local, and comparatively inexpensive reconstruction can therefore ensure that the chance of recurrence of the accident is much reduced. The cost of such local reconstruction—supposing it to be more widely undertaken than at present—would still, of course, be heavy. Yet our Government is willing to spend hundreds of millions of pounds upon the National Health Service in order to provide doctors and hospitals for those who are ill and to prevent sickness and ill-health. Is it not therefore illogical to fail to spend enough on the prevention of injury and death on the roads? Moreover, would not expenditure upon making roads safer, as every road engineer desires, bring about economies in the cost of the Health Service itself? In the present economic conditions it is obvious enough that this country must study with care how much it can afford to spend upon each of its activities. The "cake" of the nation's income must be so cut that the essentials receive the major slice and the merely desirable a lesser portion. At present the amount spent upon the roads is barely sufficient to maintain their present condition. But can it justly be upheld that the reduction of accidents upon them is merely in the "desirable" category?

Literature

Steam Turbines and Their Cycles. By J. KENNETH SALISBURY. London: Chapman and Hall, Ltd., 37, Essex Street, Strand, W.C.2. Price 72s. net.

MOST books about steam turbines deal mainly with the different designs and constructional details adopted by various makers and give quite a secondary place to such matters as the arrangements for regenerative feed-heating and other elaborations of the simple steam cycle. The present author takes quite another standpoint. He relegates the descriptions of actual turbines almost to the last chapter and then confines himself entirely to modern machines built by the American General Electric Company, with which firm he is associated. The length to which his partisanship is carried may be gauged by his assertion that "experience has shown that the multivalve [i.e., nozzle-controlled] multistage horizontal turbine is by far the most acceptable from every standpoint and we shall be concerned entirely with this type." In conformity with this policy the kinds of turbine associated with the names of Parsons, de Laval, Rateau and Ljungstrom are completely ignored and the reader might finish the volume without being aware of their existence. This disregard of everything but the practice of a single manufacturer is, fortunately, of no real importance, because the value of the book lies in its exposition of calculations relating to the heat cycle and these are applicable to steam turbines of every type. In this field we believe it to be unique or, at any rate, to have no serious rival. It is clearly the outcome of a vast experience of turbine work and treats the subject throughout from the point of view of the design office rather than that of the class-room.

The contents of the volume are divided into four parts, the first of which deals with the design of the turbine itself so far as the steam path is concerned. The reader is supposed to possess a general knowledge of thermodynamic principles, so that a short introductory chapter suffices to remind him of the most useful equations which are finally tabulated conveniently for reference on a single page. After a description of various heat cycles, including the mercury-steam cycle and the cycles used in gas turbine work, a chapter on the flow through nozzles leads up to a discussion of the efficiency of nozzles and impulse blading and to the various sources of loss in the turbine itself. The well-known Parsons Coefficient, devised by Sir Charles Parsons to correlate the efficiency of any turbine with its blade speed and the number of moving rows of blades is explained under a non-committal name, though its value is rightly emphasised.

The eight chapters constituting the second part of the book are said to cover the complete theory of the regenerative cycle and the claim does not appear to be excessive. At the outset, the academic justification for feed-heating by extracted steam, namely, that it permits of a nearer approach to thermodynamic reversibility, is supplemented by arguments that appeal more forcibly to the practical man. The theme is illustrated by actual calculations pertaining to a 25,000kW, nineteen-stage, impulse turbine with a two-row wheel for the first stage. The first step is to determine the non-extraction heat rate; the second is to find the improvement that would be brought about by heating the feed-water regeneratively by infinitely small stages to a temperature corresponding to the throttle pressure; the third step is to ascertain the fraction of this improvement obtainable by using any specified number of equally spaced and ideally perfect heaters. It is said that the benefit so arrived at will not differ by more than about 1 per cent from that obtained in practice from the same number of heaters. Even this difference, however, has a monetary value too great to be ignored in the case of a large machine, so the third part of the book is devoted to a full analysis of the performances of different regenerative cycles, with combinations and permutations of heaters of the drain-cooler, flash and contact types. The author claims to have provided a "method of evaluating and comparing cycles with an accuracy not heretofore possible," and the work is certainly done with thoroughness. In addition to the more or less obvious sources of loss in practical arrangements of heaters, the effect of including generator coolers, oil-coolers and air-ejector condensers in the feed water circuit, the subcooling of condensate in the hot-well the use of extraneous steam or water in a heater and the power absorbed by the boiler feed-pump are all considered. In the fourth and final part of the book, apart from the illustrations of turbines, to which reference has already been made, there are useful chapters on the estimation of turbine heat rates, with numerous diagrams to facilitate the task. An appendix with steam tables and a sectionalised Mollier diagram completes a volume of exceptional merit and originality. A work of this kind was much needed and we have no doubt that the present book will receive a cordial welcome

from all engineers interested in the design of large turbine plants.

Estimating and Planning for Engineering Production. By P. S. HOUGHTON. London: Blackie and Sons, Ltd., 66, Chandos Place, W.C.2. Price 25s.

THE object of this work is to provide the necessary data and information required by production personnel to record all details relevant to the production and assembly of components. In this way only may an effective control be exercised over plant requirements, pattern and tool changes, material allocations and production times.

By far the greater part of this book is given to the establishment of optimum conditions for the machining of ferrous and non-ferrous materials. As a basis for this the author has used data published by the American Society of Mechanical Engineers, which consist of tables showing speeds, feeds and depth of cut for machining steel, cast iron, brass and aluminium when using carbon, h.s.s., stellite or carbide single-point tools of varying shape. These standard tables, as such, are only applicable to materials of one specification. Further tables are therefore included giving constants which, when suitably applied in conjunction with the original tables, enable a cutting speed to be obtained for the machining of a comprehensive range of materials. These tables are based on a tool life of one hour (cutting dry), which is considered to be a most economical time.

As there are so many variable factors that enter into the determination of a cutting speed, provision is made by application of suitable constants for the varying factors that influence the cutting of metals. For instance, in the case where a longer tool life is required, or a cutting fluid is used, further constants can be applied to arrive at the recommended speed.

The author has attempted to broaden the scope of the data on single-point tools to cover machining operations such as milling and gear cutting. Tables are given relating the cutting speed for single-point tools with that of other machining operations.

Recommendations can be obtained to suit the varying conditions of given machining operations. In this respect, this book differs from many other reference books which concern themselves only with overall recommendations for machining different materials, and do not take into account factors such as varying tool angles, nose radius, use of lubricant, tool life, and condition of material.

Further chapters deal with the estimation of material requirements, cutting speeds and machining times. The various details that have to be considered when process planning numerous operations, are discussed and tabulated. Times are given for welding and flame cutting. Reference is also made to a multitude of other factors concerned with production engineering. Many examples are given in estimating.

Physics in Chemical Industry. By R. C. L. BOSWORTH. London: Macmillan and Co., St. Martin's Street, W.C.2. Price 70s.

IN the many discussions and reports on higher technological education which have been published recently the importance of physics and physical chemistry as indispensable elements in the training of technologists for the chemical and allied industries has been repeatedly emphasised. The primary technology of which these subjects form the basis is chemical engineering, and Dr. Bosworth's book, "Physics in Chemical Industry," although in no sense a textbook on chemical engineering, is a useful addition to the literature of this subject.

In some respects it is disappointing that the author has not dealt more specifically with the basic or unit operations of chemical industry as a convenient means of achieving his object, namely, that of "developing those branches of physics which are of fundamental importance to many of the operations concerned in industrial chemistry." The lack of a clearly defined plan in the preparation of the book has led to the inclusion of some irrelevant matter and to an inadequate and often sketchy treatment of some important aspects of the subject.

The book is divided into four parts, the first of which is concerned with aspects of applied mathematics in which mechanical, geometrical and other types of devices are used to simplify mathematical operations. There is an excellent chapter on the method of dimensions and two further chapters are devoted to statistics and the theory of errors. Part II treats of the properties of matter and gives special attention to rheology, the properties of liquid surfaces and adsorption. Part III deals with the movement of matter and includes an extensive and detailed treatment of diffusion and of transflux phenomena of various kinds. Part IV, under the heading of "Scientific Instruments," describes methods and devices for measuring, recording and controlling mass, pressure, viscosity, fluid flow and temperature.

It will be seen that the ground covered is both extensive and varied and a considerable amount of selection and condensation has been inevitable. On the whole, the author has shown good judgment, although there are a number of instances in which the treatment is inadequate and the literature references are incomplete. Thus, for example, the important problem of the flow of fluids through granular solids is dismissed in one page with no references to recent work, the subject of the drying of solids receives only incidental treatment, and pneumatic and hydraulic conveying are not mentioned. In spite of these imperfections, however, the book is one which many industrial chemists will like to have on their shelves and which may well, to use the words of the author, "encourage a two-way interchange of information between science and industry."

Obituary

LORD MACLAY

WE record with regret the death, at the great age of ninety-three, of Joseph Paton, Baron Maclay, of Glasgow, which occurred at Duchal, Kilmacolm, Renfrewshire, on April 24th. Lord Maclay had a long career in the British shipping industry and will be particularly well remembered by his distinguished services as shipping controller during the first world war. Lord Maclay was the son of the late Mr. Ebenezer Maclay, of Glasgow, and when quite a young man established, with Mr. T. W. McIntyre, the shipowning firm known as Maclay and McIntyre. By the outbreak of war in 1914, the firm owned a fleet of fifty cargo ships. He was created a Baronet in 1914 and, when the Ministry of Shipping was established in 1916, Sir Joseph Maclay, as he then was, was invited to preside over it and to become a member of the War Cabinet. He was raised to the peerage in 1922. In addition to his services for British shipping, Lord Maclay was a member of the Royal Commission on Coal Supplies, a member of the Clyde Trust and a Deputy Lieutenant of the City of Glasgow and Renfrewshire. He was also a member of the Committee on National Expenditure in 1921.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

HYDRO-ELECTRIC STATIONS AND COAL SAVING

SIR,—I am very concerned to learn that the Dee hydro-electric station at Chester has been closed down in order, I believe, that the building can house the pumps supplying water to the atomic station at Capenhurst. I believe it is correct to state that this station was supplying on an average of 1½ million units per year, which, on the basis of 1 lb coal per kilowatt-hour, is equal to 670 tons of coal per annum, exclusive of transporting this valuable fuel.

Surely, in these days of shortage of generating capacity and the necessity to save coal, this station should be kept in action. I agree that the capacity of this station, in comparison with thermal stations, is a mere 650kW or so, but every pound of coal saved is vital to our national economy. This installation, I am given to understand, has an excellent record of trouble-free running. The only major repairs that have been necessary during the thirty-seven years it has been operating are new crown wheels to two of the three sets installed. The remaining set has given no trouble whatsoever.

It is to be hoped that someone in authority at the B.E.A. will, in the near future, consider the construction of still more of these stations, not only on the River Dee, but on most of the main rivers in this country. These stations could be equipped with generating sets of a standard design and remotely controlled from the main station. It should not be difficult for our electrical and mechanical engineers to design such a unit, consisting of perhaps a Kaplan type turbine coupled to an induction generator (thus eliminating the expensive governor gear) built as one unit, capable of being divided into sub-units for transportation, &c., the whole unit to be lowered into vertical channels cast in the reinforced concrete structure comprising the dam or weir.

This would enable a standard design to be adopted for the civil engineering side, which could proceed without any hindrance from the mechanical department, the turbo-generator unit being dropped into position and connected up and on load within a matter of days from the completion of the dam. Needless to say, these sets should be of weatherproof construction, thus eliminating the need for buildings except at the control stations.

"HYDRO"

Chippenham, Wiltshire, April 23rd.

RAILWAY FREIGHTS AND FARES

SIR,—I read your leading article, in your April 20th issue, with much interest. I agree with you that the administration of the railways should revert to engineers and properly experienced traffic officers, to replace the present accountants, lawyers, civil servants, university men, generals, bishops, and so on! Although they often proclaim that they are satisfied that the railways are "efficiently and economically conducted," in actual fact none of them possess the necessary practical experience in the working of the lines and their traffics to be able legitimately to pronounce whether they are efficiently and economically conducted or not!

Rather than agree to carry out anything more than mediocre economies, rates have been increased since 1922 by 100 per cent, 50 per cent and 16⅔ per cent—making them 235 per cent higher than they used to be. And now they want another 10 per cent! Excur-

sion fares were very profitable at ½d. a mile. Ordinary fares are now 2½d. a mile—ten times as much! Hence, the wholesale flight (including private car and "C" licence traffic) to the roads, with a consequent huge total of accidents. This is no way of conducting nationalised transport.

E. R. B. ROBERTS.

St. Neots, April 24th.

[Mr. Roberts, in his second sentence, credits us with a statement we did not make. What we actually wrote was that "given a free hand, railway engineers . . . could improve the speed and convenience of rail transport and cheapen its cost," and we suggested that owing to Governmental restrictions on capital expenditure not enough capital was being expended upon the transport systems, road and rail, of this country. —ED. THE E.]

JOINT CONSULTATION

SIR,—In recent years there has been an increasing acceptance of the principles of joint consultation in almost every sphere of British industry, as is shown by the widespread establishment of Joint Production Committees, Works Councils and similar bodies.

I am engaged in research into the scope and methods of joint consultation at the factory level and in view of the public interest which this subject has aroused, I feel that some of your readers might make a valuable contribution to my work from their own practical knowledge and experience in this field. I would be very grateful to receive details of any scheme of joint consultation in operation in any type or size of industrial establishment; such information would be used solely for academic purposes and would, of course, be regarded as strictly confidential.

JOHN REDFERN, B.Com.,
Research Assistant

Department of Commerce,
High School Yards, Infirmary Street,
Edinburgh, 1,
April 20th.

YORK BOILER EXPLOSION

SIR,—Referring to your article in THE ENGINEER of April 6, 1951, on the Report of the York Boiler Explosion, we are particularly interested in this matter as we were manufacturers of the boiler.

No reference was made in your article to a point that is quite an important factor in people's minds, and which, naturally, we should have liked to be stressed. It is that the full report on the explosion very clearly defines that the workmanship during manufacture of this boiler was entirely satisfactory.

W. R. EDWARDS
Managing Director

John Thompson Water Tube Boilers Ltd.,
Wolverhampton, April 27th.

BOOKS RECEIVED

Petroleum Geology. By E. N. Tiratsoo. London: Methuen and Co., Ltd., 36, Essex Street, W.C.2. Price 42s.

Danger Ahead. By Richard Blythe. London: Newman Neame, Ltd., 29, Percy Street, W.1. Price 10s. 6d.

Horizontal Diesel Engines. By R. A. Collacott. London: Temple Press, Ltd., Bowling Green Lane, E.C.1. Price 8s. 6d.

Modern Railway Motive Power. By Brian Reed. London: Temple Press, Ltd., Bowling Green Lane, E.C.1. Price 8s. 6d.

Press Tool Practice. Part IV. By P. S. Houghton. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 21s.

Engineering Metrology. By K. J. Hume. London: MacDonald and Co. (Publishers), Ltd., 43, Ludgate Hill, E.C.4. Price 18s.

T.S.S. "Ocean Monarch"

No. III—*(Continued from page 550, April 27th)*

NAVIGATION AND SAFETY EQUIPMENT

THE wheelhouse and chartroom are fully equipped with modern aids for efficiency and safety; included are Marconi transmitters, receivers and direction-finder and Decca radar. Special high power short-wave radio-telephony equipment provides the passengers with direct telephone communication with their business premises.

Provided throughout the ship are systems of fire prevention, detection and alarm which more than comply with official requirements. To restrict the spread of a fire, fireproof screen bulkheads, sprayed with limpet asbestos, are arranged at selected positions. The fireproof doors fitted in the bulkheads are of "Castador" sliding, double-sided, collapsible gate pattern and hinged "Dreadnought" doors, steel-panelled on both sides. Protection of the public rooms, staterooms and crew accommodation is effected by a "Grinell" automatic sprinkler and fire alarm system, which is divided into fifteen sections, with separate alarm recorders incorporated in a panel placed in the wheelhouse. A Kidde Rich installation of CO_2 cylinders and associated piping is fitted and provides sufficient gas to deal with any fire occurring in the holds, while for extinguishing oil fires in the boiler-room there is a total flooding system. A smoke detector and indicator is mounted in the wheelhouse. Additional protection is provided by a number of portable water/soda fire extinguishers, which are distributed throughout the vessel, and by foam extinguishers placed where there is a possibility of an oil fire.

To control underwater damage and to maintain the intactness of the ship's subdivision, a total of fourteen horizontal sliding watertight doors, manufactured by Broadfoot and Sons, Ltd., are installed. Each door is arranged for hand and electrical operation. An electric control system, provided by J. Stone and Co., Ltd., operates each door through gearing driven by a 2 h.p. motor controlled from both sides of the bulkhead and from the bridge, where an indicator panel is placed. To assist in opening a door from the tightly wedged position an arrangement of levers comes into operation during the first ¼in of movement and increases the power applied, by three to four times.

The life-saving arrangements consist of a total of nine lifeboats, having an overall capacity for 712 persons, which are hung in Welin MacLachlan gravity davits, operated by electric winches. Built by Hugh McLean and Sons, Ltd., of aluminium alloy, there are five 32ft 6in and two 26ft lifeboats, all fitted with Flemings hand propelling gear, and two 35ft motor lifeboats, each fitted with a 45 h.p. Gardner diesel engine. All the boats are equipped with Schat skates to avoid damage during launching.

PROPELLING MACHINERY

The half-tone illustrations and plan view drawing of the engine-room and boiler room show the general arrangement of the machinery spaces. The propelling machinery consists of two sets of geared turbines of Pametrada design, developing 11,500 s.h.p. at 150 r.p.m. of the propeller, and taking steam at 425 lb per square inch gauge and 750 deg. Fah. Incorporated in the l.p. turbine casings are the astern turbines, which develop a total of 6500 s.h.p. When cruising at an economical speed the turbines develop about 8000 s.h.p.

The h.p. ahead turbines have end-tightened impulse blading, with locking strips of Lowmoor iron, the impulse wheels being forged solid with the steel rotor shaft. The casings are of cast steel and the nozzle-plates are of built-up pattern to Pametrada design. At the aft end of the casing is a double pocket steam gland, while at the forward end a treble pocket gland is fitted, together with a leak-off pocket exhausting to the bled steam belt on the turbine. The l.p. ahead turbines are of single-flow impulse reaction design, having a single-row impulse wheel followed by fourteen rows of reaction blading. In the casing all the reaction blading is segmental, while in the rotor the first ten rows are segmental, the remaining four rows being integral blades. Housed in the l.p. ahead turbine casing is the astern turbine, which consists of two three-row impulse wheels, the moving impulse wheels being forged solid with the l.p. ahead rotor. Cast iron is the material used for the l.p. ahead casing and cast steel for the astern section. Double-pocket steam glands are fitted to each end of the l.p. casing.

All the impulse blading and also all the integrally fitted reaction blading is of chromium iron, while the segmentally fitted reaction blading is of monel metal. Nozzle segments, which are secured to mild steel holders and retaining rings, are of chrome iron. Arranged in the same casing are an ejector condenser and one gland condenser, with a total surface of 105 square feet, which handles all the vapour from the turbines and maintains a vacuum adequate enough to ensure evacuating the most distant gland pocket. In both the h.p. and l.p. ahead turbines thrust dummies are fitted and any unbalanced thrust is taken by Michell thrust bearings. All turbines are fitted with Aspinall's cut-out governors, which are set to shut off steam at a predetermined number of revolutions per minute; another safeguarding arrangement is that steam is automatically shut off in the event of the lubricating oil pressure dropping unduly.

GEARING

Double-reduction articulated gearing is fitted, having two first reduction gears, one for the n.p. turbine and one for the l.p. turbine, driving secondary pinions on the main wheel. A fabricated casing, welded integrally with the second reduction gear-case, houses the first reduction gear. A claw-pattern flexible coupling connects each turbine to the gearing, while the primary gears drive the secondary pinions through flexible couplings and quill shafts.

Both the h.p. and l.p. primary pinions have a face width of 18in and pitch circle diameters of 8·784in and 13·926in respectively, while both primary wheels have a 43·705in pitch circle diameter by 18in face width. The h.p. and l.p. primary gears, which are enclosed in a fabricated steel casing, have nickel steel pinions and the first wheels have cast iron centres with forged steel rims shrunk on. The h.p. and l.p. secondary reduction pinions have a pitch

circle diameter of 14·392in by 33in face width, with a 3in gap. For the main wheels the pitch circle diameter is 108·199in and the face width 33in.

The forged steel quill shafts, the nickel steel secondary pinions and the main wheels, which have forged steel rims shrunk on to cast iron centres, are all enclosed in a fabricated steel casing. The speeds of the h.p. and l.p. turbines are 5610 r.p.m. and 3540 r.p.m. respectively, and the gear ratio makes the corresponding shaft speed 150 r.p.m. Fitted on each l.p. primary pinion shaft is the electrically operated turning gear, which is of sufficient power to turn the main shafting one revolution in ten minutes. Cast independent bearing bushes are fitted and arranged for removal without lifting the main gearcase covers.

Three "Vertoil" pumps, two working and one standby, ensure the lubrication of both turbines and gearing. The pumps, each of

Boiler Plant

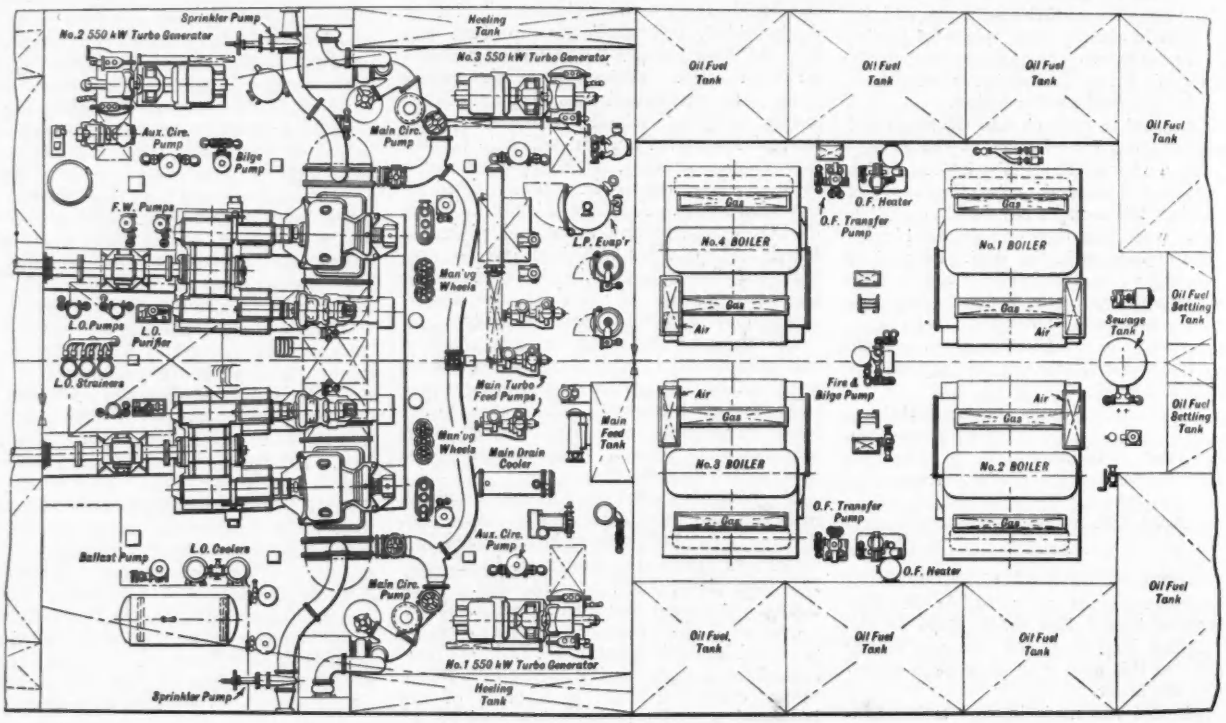
The steam generating plant consists of four Yarrow three-drum, single-flow, end-fired, water-tube boilers, which supply steam at 450 lb per square inch gauge and a temperature of 750 deg. Fah. at the superheater outlet. The output of any three boilers is sufficient for the turbines to develop enough power for the ship to maintain a speed of 18 knots. Each boiler has hollow forged steel steam and water drums, with integral closed ends and "Melesco" superheaters, so arranged between the nests of tubes that there is only a small variation in steam temperature over a range of output. The generating surface for each boiler is 6710 square feet and the superheating surface 1450 square feet. There is a Cockburns self-closing stop-valve and the steam drums

ejector maintains a partial vacuum to draw the soot away and after the addition of water the soot is ejected through the ship's side, the force being adequate to carry it a distance of 10ft clear, sufficient to avoid fouling the paintwork.

A Wallsend oil fuel installation is fitted and consists of two Simplex pumping and heating plants, each of which can deliver 10,000 lb of oil fuel per hour. The heaters are thermostatically controlled and there are four burners per boiler.

Closed Feed System

The Weir closed feed system consists of two underslung regenerative condensers, arranged for inboard tube withdrawal, with a total cooling surface of 9860 square feet and capable of maintaining a vacuum of 28in with the sea temperature at 82 deg. Fah. The tubing is of ¾in outside diameter by No. 18 gauge aluminium brass contained



Engine Room Arrangement

8150 gallons per hour capacity against a pressure of 50 lb per square inch, plus 10ft suction lift, deliver the lubricating oil through "Flush Flo" filters and Serck coolers to gravity tanks, which ensure an oil supply should the pumps fail. Bearings can receive oil direct from the pumps by means of a by-pass. Magnetic oil strainers are fitted to each pump suction and there are two electrically-driven centrifugal oil purifiers, each of 250 gallons per hour capacity and equipped with electric heaters.

The Michell thrust blocks are fitted independently of the main gearcases and arranged for forced lubrication, while the Michell tunnel bearing blocks are self-lubricating, the trailing bearing being the fourth from aft. The solid forged steel shafting, which has solid flanged couplings, is well raked and is of 14in diameter raised ½in at the bearings, while the propeller shafts are 15⅝in diameter and fitted with continuous gunmetal liners. Manganese bronze solid four-bladed variable-pitch propellers, manufactured by J. Stone and Co., Ltd., are fitted. They are outward turning with a tip clearance of about 3ft

are fitted with low-level alarm and oil fuel safety shut-off gear.

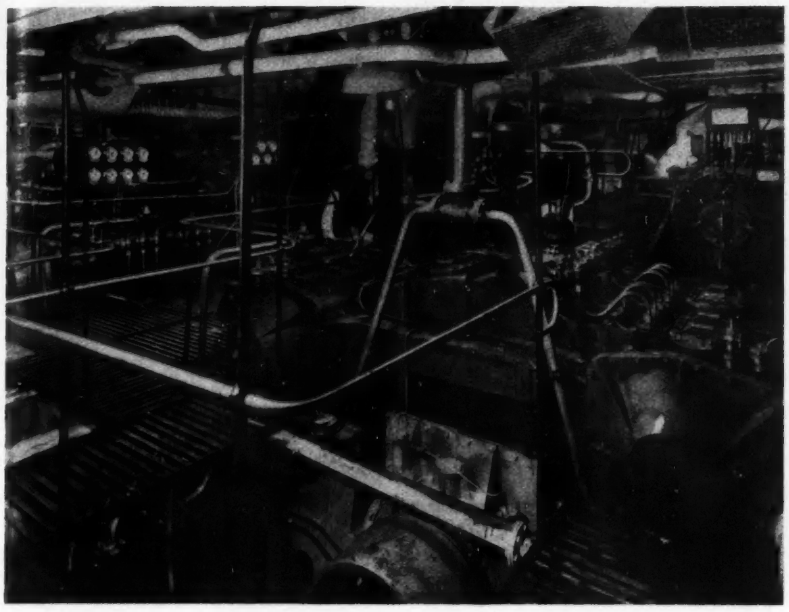
The boilers burn oil only in an open stokehold under Howden's balanced system of forced draught. Four electrically-driven forced draught fans maintain the system, each delivering 13,625 to 15,000 cubic feet per minute against an air pressure of 7in to 8·5in water gauge, and there are four induced draught fans each capable of dealing with 21,700 to 25,000 cubic feet per minute against a static air pressure difference of 3·25in to 4·25in water gauge. The trunking from the forced draught fans is arranged so that by the manipulation of dampers any air heater can be blanked off and any fan can be connected to any heater. A three-pass air heater of vertical tubular design, having a heating surface of 7225 square feet, is provided for each boiler and mounted in the uptakes; by-pass arrangements are included for slow steaming.

Clyde steam-driven soot-blowers are fitted to air heaters and boilers and in the uptakes of each boiler a Howden "Vortex" dry upflow dust collector is mounted. A steam

within a mild steel plate shell and packed with Crane's packing. Bolted to the condenser shell are two direct-operated closed-feed control valves, each consisting of a 3in bore supplementary feed valve and a 2in bore overflow valve, operated by a single float. There are two turbine-driven main feed pumps—each having a normal capacity of 116,000 lb per hour and an overload output of 151,000 lb per hour against a discharge pressure of 575 lb per square inch—and a harbour service feed pump for which the corresponding capacities are 45,000 lb and 60,000 lb per hour. The two electrically-driven extraction pumps can each deal with 116,000 lb per hour normal load and 151,000 lb per hour overload, while the two three-stage steam jet air ejectors can each handle 21·8 lb of air, associated with 24 lb of vapour per hour.

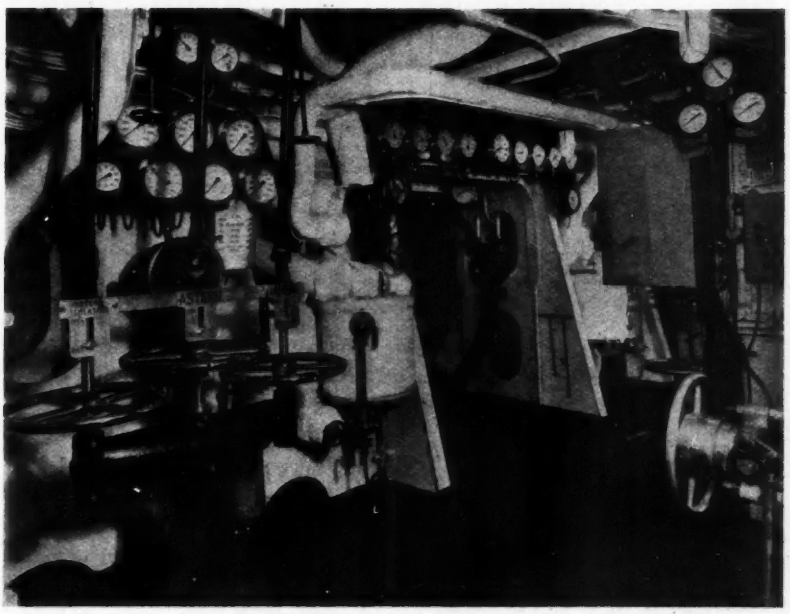
One main drain cooler is provided and has a surface of 400 square feet and can pass 116,000 lb of feed water per hour. Three heaters raise the temperature of 116,000 lb of feed water per hour in three stages from 140 deg. to 207 deg. Fah., 207 deg.

to 270 deg. Fah., and 270 deg. to 320 deg. Fah., while an auxiliary feed-water heater can raise 45,000 lb per hour from 120 deg. to 220 deg. Fah. Especially useful for starting from cold and after fumigation is an electrically-driven three-throw reciprocating harbour feed pump with



ENGINE ROOM

a capacity of 5000 lb per hour against a discharge pressure of 575 lb per square inch. This can pump up the boiler, which can then be fired to raise enough steam to work an induced draught fan and so clear the boiler-room without the crew having to work in



STARTING PLATFORM

gas masks. For boiler protection purposes a pressure chamber system is fitted for the injection of a boiler feed-water treatment compound.

Auxiliaries

With the exception of the feed pumps, all the remaining auxiliaries are electrically-driven and many are arranged for plural starting, a separate switchboard being provided by the General Electric Company, Ltd., and mounted on a platform at the forward end of the engine-room. The pumps, most of which are controlled by the Pneupress system, are by Weir and Drysdale with driving motors supplied by W. H. Allen, Sons and Co., Ltd., Metropolitan-Vickers Electrical Company, Ltd., and Laurence Scott and Electromotors, Ltd. Of upright pattern, the main circulating pumps can each deliver 7500 gallons per minute against a head of 26ft and their high and low inlet piping terminates in fabricated steel plate suction boxes welded to the shell plating. For service with the heeling tanks a pump with a capacity of 60 tons per hour against a 50ft head is supplied.

Ventilation of the machinery spaces is by Thermotank axial flow fans. Four 35in diameter "Phantom" fans, mounted at the level of the sun deck, supply the engine-room, each delivering 14,000 cubic feet per minute against a pressure of 1½in water gauge and two 45in diameter "Torpedo" fans at boat deck level, each capable of delivering 24,000 cubic feet per minute against a pressure of 1½in water gauge, supply the boiler room.

The electrical load is met by three turbo-generators, manufactured by W. H. Allen, Sons and Co., Ltd., having double commutators and each with its own condenser and extraction pump. Two generators are arranged to starboard and one to port and each is rated at 550kW, 220V, d.c. The turbine drives the generator through a single reduction gear, the reduction being from 7000 r.p.m. to 1000 r.p.m. Supplied by Sunderland Forge and Engineering Company, Ltd., the main switchboard is fitted on a flat at the after end of the engine-room. For a.c. lighting purposes, the public address system and lift controls, two 40kVA, 50 cycle, single-phase alternators driven by 55 h.p. motors, provided by the General Electric Company, Ltd., are fitted on a flat to starboard. One set can take the whole load, the other acts as a standby and the control gear is arranged so that in the event of one alternator stopping the other automatically starts up. The engineer's workshop is situated in a compartment on "C" deck to starboard, from which access is gained to the engine-room. It is well fitted out with electrically-driven equipment.

Institution of Electrical Engineers

At an ordinary meeting of the Institution of Electrical Engineers in London on Thursday evening of last week, the forty-second Kelvin Lecture was delivered by Sir John Cockroft on "Modern Conceptions of the Ultimate Structure of Matter." Prior to the Lecture, the Certificate of Honorary Membership of the Institution was presented to Mr. Philip Vassar Hunter, C.B.E., Past-President. In making the presentation, the President, Sir Archibald Gill, stated that the distinction of Honorary Membership had been conferred upon Mr. Hunter for his outstanding services to the electrical industry and to the Institution. Mr. Hunter, who is deputy chairman of B.I. Callender's Cables, Ltd., and chairman of B.I. Callender's Construction Company, Ltd., has devoted special attention to the development of electrical transmission. He invented the split conductor and several systems of automatic discrimination for electric power transmission systems and improved forms of transmission cable. Mr. Hunter was President of the Institution in 1933–34, and has represented it on many important committees. He is a Fellow of the American Institute of Electrical Engineers.

Another presentation made by Sir Archibald Gill at last Thursday's meeting was that of the Faraday Medal for 1950 to Sir James Chadwick, F.R.S., for his distinguished work in nuclear physics and on radio-activity. Sir James became Master of Gonville and Caius College, Cambridge, in 1948, and has been scientific adviser to the United Kingdom on the United Nations' Atomic Energy Commission since 1946. He became a Fellow of Gonville and Caius College, Cambridge, in 1921, and collaborated with Lord Rutherford in research work at the Cavendish Laboratory; the fundamental researches which they conducted laid the foundations on which the structure of modern nuclear physics rests. Sir James's discovery of the neutron, which opened the way to the fission of the nucleus of the uranium atom, was recognised in 1935 when he was awarded the Nobel Prize for Physics. His services during the second World War in connection with the developments in the use and control of nuclear energy were recognised in America by the award of the U.S. Medal of Merit.

Structural Engineering at the South Bank Exhibition

No. I

A LARGE exhibition, such as that on the South Bank, makes unusual demands upon the architect and the structural engineer. Exhibition buildings provide an opportunity for innovations in structural design and originality of architectural treatment, perhaps by experiment with some new constructional material or idea which would not be suitable for other purposes. In the past, such buildings have, in several cases, exercised a significant influence on the trend of development. Probably the best known example, and one which is worth mentioning for comparison, is the Crystal Palace, which eventually came to be looked upon as a prototype of modern constructional styles. The extent of any influence which the Festival of Britain buildings may have on future construction cannot, of course, be assessed at present, but it is evident that the South Bank site has a considerable and a varied architectural appeal. The structural engineer will also find a great deal of interesting work there, and it is intended in this article to give an account of the engineering aspects of the various buildings.

Several of the most recent trends in structural engineering have been utilised in the design of the various buildings. There are examples of work in prestressed concrete, welded steelwork and timber, and the use of aluminium alloy is exemplified by the principal exhibition building, the Dome of Discovery. In fact, the Dome of Discovery has already been the subject of a certain amount of controversy. The view has been expressed that it is the most interesting structure which has been built since the construction of the airships "R 100" and "R 101"; on the other hand, its conception has been criticised, and it has been pointed out, for instance, that the area of the roof is considerably in excess of the floor area. Nevertheless, it undoubtedly has considerable engineering interest, and a brief description of its structure is given below, followed by some notes on various other buildings on the South Bank site.

The Dome of Discovery

The dome is 365ft in diameter (measured to the pitch circle of the pin joints at the bottom of the struts), and consists of a number of aluminium alloy ribs arranged as great circles, as shown in the accompanying illustration. The ribs are braced, and are triangular in cross section; at the periphery of the dome they abut against a steel ring girder. The ring girder is supported on tubular steel struts. The aluminium roof sheeting is held on to the roof framework at intervals, and is free to move laterally to take up temperature variations. The hall which the dome covers is eccentric to the centre of the dome, so that the latter forms a canopy on one side, over one of the entrances to the exhibition. The shape of the hall is clearly shown in our illustration; there is also a gallery running round the hall, the reinforced concrete supports for which are shown in the sectional plan.

The two photographs reproduced overleaf show the dome during construction. The steel ring girder, with an aluminium canopy outside it, may be seen in the first illustration, together with the tubular steel supporting struts. The second illustration gives an idea of the framing of the dome, and shows the reinforced concrete gallery inside it. The completed dome is shown in the accompanying Plate 4.

Owing to the unusual nature of the design of the dome, the opportunity was taken in a short period which was available after completion to load it with test loads suspended by wire ropes from the panel points, and to measure the resulting stresses at various places. The tests indicated that the structure could carry a superimposed load of 10 lb per square foot over half its surface with a maximum stress in the ribs of some 4½ tons per square inch.

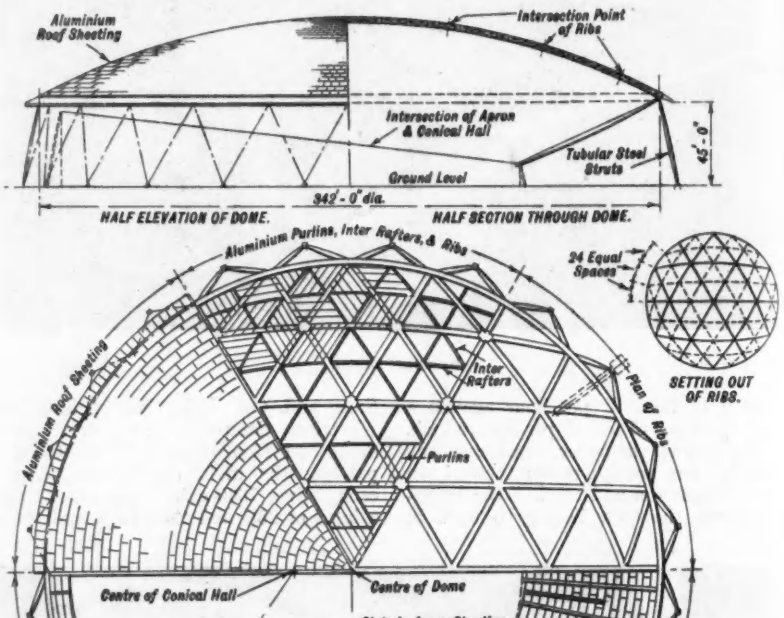
The consulting engineers for this work were Messrs. Freeman, Fox and Partners, the architect was Mr. Ralph Tubbs, and the contractors were Horseley Bridge and Thomas Piggott, Ltd., and R. Costain, Ltd. For a fuller description of the design of the dome, two references are given below.[1, 2]

Prestressed Concrete Work

There are two interesting examples on the South Bank site of prestressed concrete construction—a footbridge built near the shot tower in the "downstream" section, and the roof of the restaurant near the Waterloo gate entrance. Although relatively unobtrusive compared with some of the other buildings, the prestressed roof of the restaurant is of considerable technical interest. It is shown under construction in an illustration reproduced on page 586, from which it may be seen that it consists of a grid of beams running at 45 deg. to the lines of the walls of the room below.[a] The room is a rectangle of about 50ft by 60ft, and the beams are spaced at intervals of 10ft, measured along the walls. The beams themselves consist of precast elements, each 1ft 3in deep, 3½in wide and 6ft 9in long, lightly reinforced for handling. A single prestressing cable, with Freyssinet anchorages, runs along each beam, the rectangular spaces at each beam intersection being grouted. This grouting was the only "wet" work involved in the erection.

The framework formed by the grid of beams is a complex one to analyse. The interaction between the beams under given loading conditions is such that the entire frame must be considered for analysis, except in the case of symmetrical loading when a quarter of the frame may be taken. There are then 10 degrees of redundancy in the quarter frame. A development of the Muller-Breslau method, which has been evolved in the consultant's office, formed the basis of the analysis.

The technique of prestressing is particularly valuable in an instance such as this one. Having ascertained the stress distribution in the structure due to the external loads, a second analysis of the stresses due to the cables is made, the eccentricity of the cables being arranged with the object of keeping the size of the elements to a minimum and giving a closer approach to an ideal structure in which each part is equally stressed. As may be observed from the illustration, a very



THE DOME OF DISCOVERY

[1] THE ENGINEER, July 7, 1950, page 10.
[2] Institution of Civil Engineers Structural Paper No. 28, "The Structural Design of the Dome of Discovery, Festival of Britain, 1951," by Gilbert Roberts, April 3, 1951.

light construction has sufficed to support the 300 square feet of roofing.

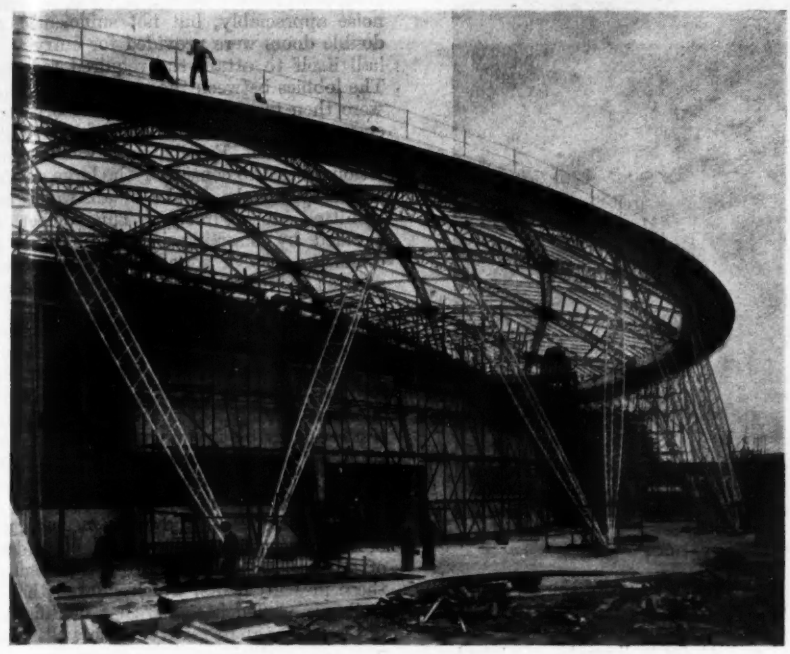
The precast elements were identical, except for the longitudinal hole left for the prestressing cable, which was detailed by a dimension at each end of the element. Great care was necessary whilst the post-tensioning was being carried out; the male cones of the Freyssinet anchorages do not lend themselves readily to the application of prestress in increments, so that unstable conditions were caused as successive cables were stressed, each to the full amount. A programme of tensioning was therefore detailed beforehand, including the order of stressing the cables, instructions for the placing and removal of kentledge at various points as the stressing continued, and similar instructions relating to propping. This programme was rigidly adhered to throughout the tensioning process. When prestressing was complete, the centre of the roof had risen by about ⅜in. Construction was completed with a light roof covering. The design allowed for a superimposed load of 15 lb per square foot, and wind loads according to Chapter V of the Codes of Practice.

The footbridge mentioned above exemplifies the lightness of prestressed concrete construction, and harmonises well with the light and colourful style of the neighbouring buildings, as may be seen from our illustration of the completed structure. Some details of the design of the bridge are shown in the diagrams on page 587. It is a continuous beam bridge of four spans, the Freyssinet system of prestressing being employed, and was designed for a load of 100 lb per square foot; one of the diagrams shows a cross section at mid-span.

The columns were prestressed with a single cable, which has been left exposed at each side of the column. The arrangement at the foot of the column is also shown on page 587; the anchorage cones of the column cable were placed in the bridge deck directly above the column. The columns at each end of the footbridge and the centre column were constructed with a hinge at their top and bottom, so that they could take up the movement caused by prestressing the deck. On completion of the work, with the columns prestressed and the hinges grouted, it was considered that they would then be, in effect, "encastré" at the top and bottom. Each column is founded on a reinforced concrete base, about 16ft by 8ft and 18in deep.

To reduce the loss of prestress due to friction of the cables, which followed a curved path on account of the continuity of the various spans, the bridge was built in two parts. The two left-hand columns shown in the plan, together with the span between them and a 27ft cantilever into the second span, were first constructed. The column cables and eighteen of the twenty-four longitudinal cables were then tensioned. The last three columns and the spans between them were then built, including a 27ft cantilever into the second span, leaving a space at the centre of that span sufficient for operating the prestressing jacks. Eighteen of the twenty-four longitudinal cables were again tensioned. The "dog log" span was, of course, stressed as a separate operation. The central part of the second span was then built, and the last six cables tensioned from each end of the straight part of the bridge. Immediately after prestressing, it was found that the tension in these last six cables was about twice as great at the anchorages as at the centre, due to friction loss.

The consulting engineers for the two prestressed concrete structures described above were Messrs. Ove Arup and Partners. The contractors for the restaurant roof were R. Costain, Ltd., and for the footbridge, Kirk and Kirk, Ltd.



STEEL RING GIRDER AND SUPPORTING STRUTS FOR THE DOME

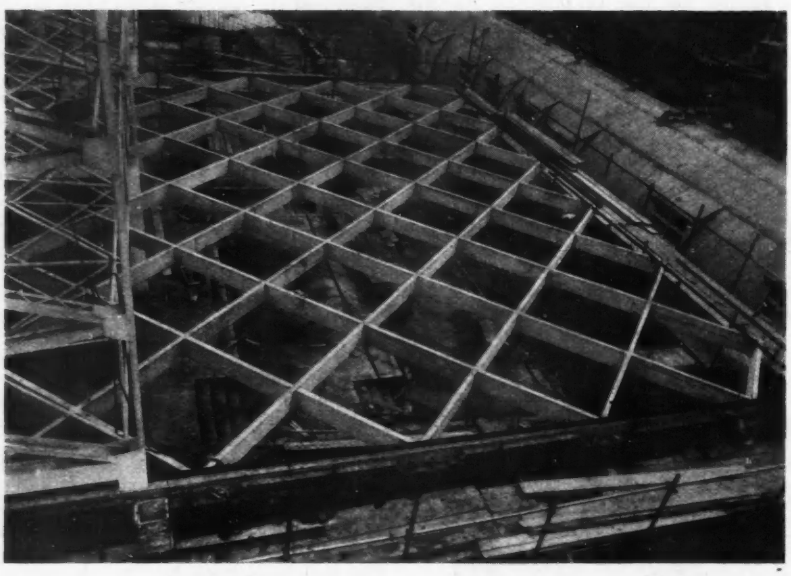
ERECTION OF INTERNAL FRAMING OF THE DOME

THE ROYAL FESTIVAL HALL

The Royal Festival Hall, unlike the other buildings on the South Bank site, is a permanent structure. Its construction has been the responsibility of the London County Council, and not the Festival authorities, and it forms part of the development scheme for the area. The first stage of construction, consisting of about five-sixths of the entire building, has been completed in time for the Festival opening, with a temporary end wall, beyond which a small hall will be built later. The hall is noteworthy for the advances in acoustic treatment which have been incorporated in its design. Some interesting structural problems had to be solved as a result of these acoustic requirements, and the work was complicated still further by the limited construction time which was available.

At an early stage in the work the Building Research Station in conjunction with the acoustic consultant for the hall, Mr. Hope Bagenal, was asked to make measurements of the noise on the site and to give an opinion on the practicability of measures for sound insulation. It was found that the intensities of noise were quite high—of the order of 90 decibels—particularly at the low frequencies which are the most difficult to exclude. Sound insulation is now, however, a well-understood technology in Great Britain (largely through the work on houses and flats), and the research station felt that the

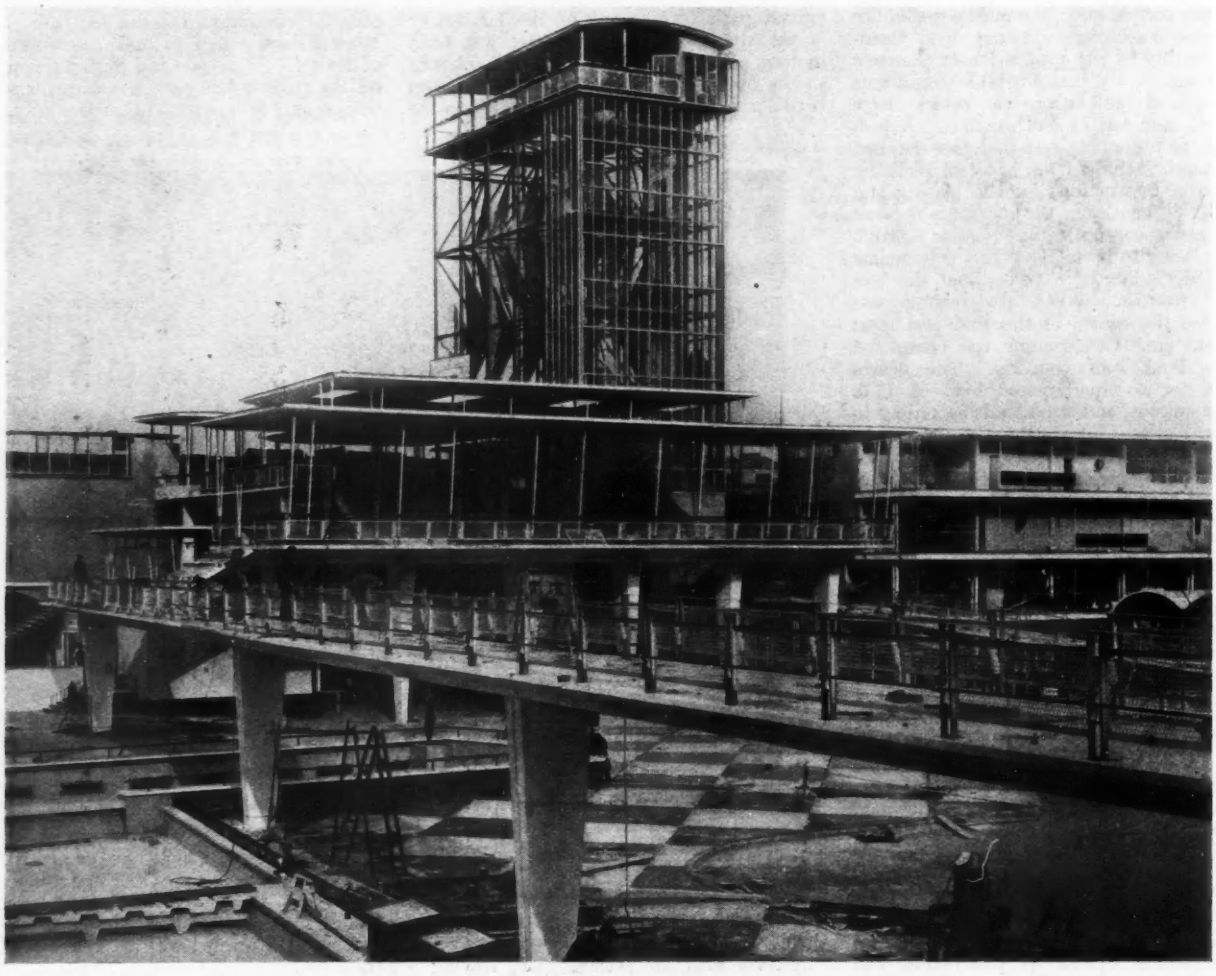
train noises could be kept out without serious difficulty. There was also the problem of underground train noise. Some lines pass directly under the hall, so that vibration measurements were made in basements of existing buildings on the site. Vibrations of this kind, it was thought, would be exceedingly difficult if not impossible to insulate in a building, but it was concluded at the time that they were not likely to cause annoyance in the completed hall. The precautions necessary to exclude the noise of the trains on Hungerford Bridge played a large part in the design of the building from the outset.



PRESTRESSED CONCRETE RESTAURANT ROOF

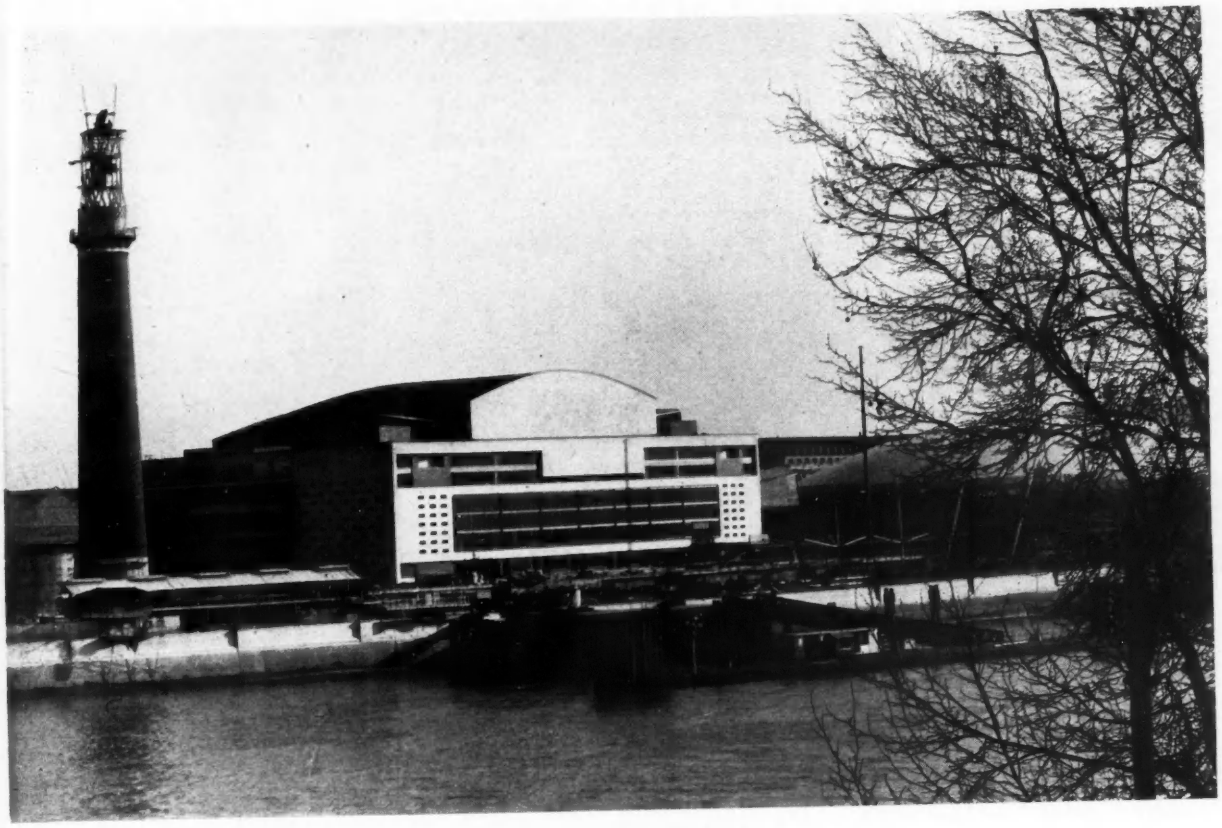
The hall itself was to have a double construction, both for walls and roof. The lower parts of the hall containing the entrances automatically get some extra protection from the surrounding structure of foyers, offices, &c., but to improve their usefulness for insulation, the ceilings of large parts of the foyers were treated with special sound absorbents, especially on the parts of the building nearest the bridge itself. These absorbents could be relied upon to reduce noise appreciably, but not sufficiently, and double doors were provided for entry to the hall itself to attain the required reduction. The lobbies between the sets of double doors were then treated with sound absorbents to ensure that they, too, acted so far as possible as sound locks. Finally, there was the ventilation system to consider; the large openings necessary for the intake of air would have admitted noise freely. This defect was avoided by inserting in the entry to the ducts a series of sound-absorbent splitters, such as are used to reduce the noise of aero-engine test houses.

The most doubtful part of the precautions, and the most important, was the double shell providing the only acoustic protection for the exposed part of the hall. It was, therefore, thought desirable to build a small test structure on the site, using the same construction as that proposed for the walls and roof. This structure was built at the same time as the early foundation work of the hall was in progress, and many measurements of noise were made inside it. The final design of the hall was detailed from the results of these measurements, which showed that the walls were adequate, but that modifications of the roof were necessary. The walls consist of two 10in thicknesses of concrete separated by a cavity which is lined with wood wool



PRESTRESSED CONCRETE FOOTBRIDGE AND WATERLOO BRIDGE GATE

BUILDINGS AT THE SOUTH BANK EXHIBITION



L.C.C. ROYAL FESTIVAL HALL

TRANSPORT BUILDING

BUILDINGS AT THE SOUTH BANK EXHIBITION

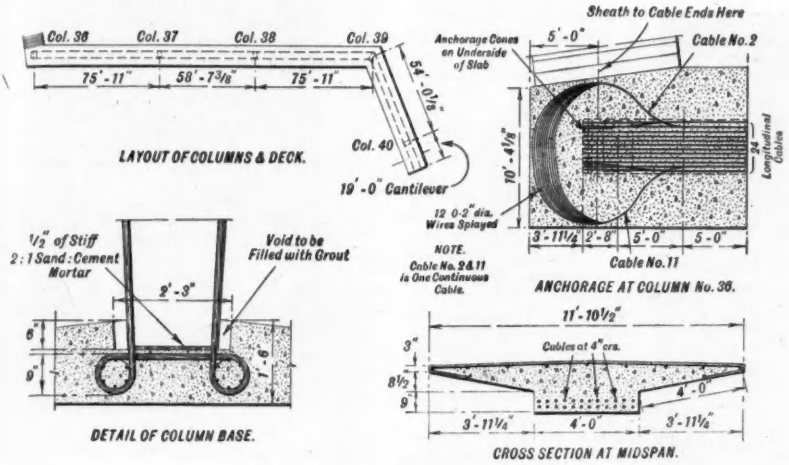
DOME OF DISCOVERY AND WATERLOO ENTRANCE

SUSPENDED OFFICES, ROYAL PAVILION AND OTHER BUILDINGS IN SOUTH CORNER OF THE SITE

as a sound absorbent. The roof consists of two layers of concrete of about half the wall thickness separated by a much larger air space, the upper leaf being carried on the lower by brick sleeper walls, but insulated from it by a layer of glass wool. Measurements on the site since the completion of the building have shown that this part of the construction is giving the insulation expected of it.

On completion, various acoustic checks and the tuning of the hall were carried out, for which purpose some test concerts were held. It was evident from the results that the noise of trains from Hungerford Bridge had in fact been successfully excluded. At the same time, an appraisal was made of the noise from the underground trains, which, it was found, was just audible under quiet conditions; computations suggested that for about ten seconds in every ten minutes its loudness might reach that of the noise from a very attentive audience. Therefore, if a quiet passage of music should happen to coincide with a passing train, it might just be detected by listeners if they were in fact trying to hear the trains rather than the music. It was not thought that such a noise would be a cause of any annoyance to concert goers.

Subsequent studies in other concert halls have shown that they suffer from intruding noise to much greater extent than was supposed at the time that the Festival Hall was designed. Much more careful exclusion of noise would be desirable in all concert hall structures built in the middle of a city. The low-frequency noise which is to be found near a busy traffic route is, in fact, little different in loudness from the noise of the trains on Hungerford Bridge, which originally seemed exceptional chiefly because the district is otherwise relatively quiet.



DETAILS OF PRESTRESSED FOOTBRIDGE

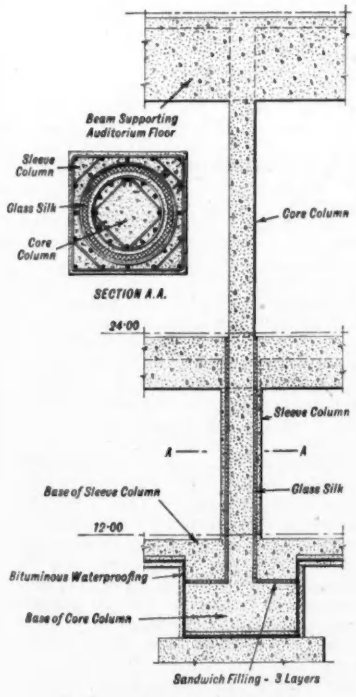
Design and Construction

The Festival Hall is of reinforced concrete construction, with steel roof trusses supporting the double roof. The acoustic requirements complicated the work considerably, and entailed heavy loads. For instance, the load on the roof trusses is about 1¼ tons per foot run. The top chords of the trusses form an arch with the inner shell of the roof, the bottom chords acting as ties. A suspended ceiling and orchestra canopy are hung from the trusses.

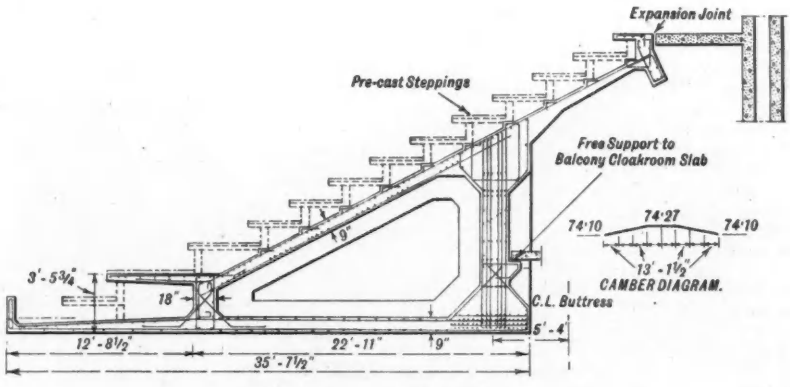
The auditorium is at a fairly high level in the building, and is carried on circular columns. The height and slenderness of these columns made it necessary to stiffen the structure, so that the staircases at the corners were substantially proportioned to act as buttresses. The small hall is structurally separated from the main hall, to prevent the transmission of noise where the main hall columns passed through the small hall structure. The separation was effected by sleeved columns as indicated in one of the accompanying diagrams, the core column carrying the main hall and the sleeve the small hall. The main balcony is separated structurally from the rear wall of the auditorium, and comprises a "box" structure, the deep face of which forms a girder spanning the hall and carrying the vertical loads, the box itself taking up torsional loads due to an eccentricity of its centre of gravity with the main girder. The illustration below shows this construction.

It is worth recalling that the hall was erected in twenty months. Such a short period reflects credit on all those involved, and necessitated careful planning of the work. The site was cleared and excavated by machine to a level 6in above the required formation, this method being considered more speedy than excavating separate pits for the deep footings, particularly on a site such as the South Bank, where obstructions from old buildings and works were to be expected. The site was dewatered with a well-point installation[3] during the early stages of the work. The work was complicated by the fact that the footings of Hungerford Bridge were not as substantial as might have been expected, and there was seepage from the river through the old river wall, so that lines of steel sheet piling had to be driven along the two sides of the site adjacent to the bridge and the river. Generally, concrete was placed by concrete pump from a central concrete plant, which included facilities for warming the aggregates in frosty weather. The nature of the work was such that repetitive shuttering was not possible to any great extent, so that the shuttering was generally of timber. The roof trusses were brought to the site in half-trusses, and were lifted by crane and rolled, in pairs, to their final positions.

The notes above indicate briefly the problems of the design and construction of the Royal Festival Hall, fuller accounts having been given in the references below.[4, 5] The two detail drawings of the hall reproduced with this description have been taken from the first of the references.[4] The completed hall is shown in Plate 3. The consulting engineers were Messrs. Scott and Wilson, and the London County Council's chief architect and his staff were responsible for the architectural design; the main contractors were Holland and Hannen and Cubitt, Ltd.



SLEEVED COLUMN DETAILS



MAIN BALCONY BEAM

(To be continued)

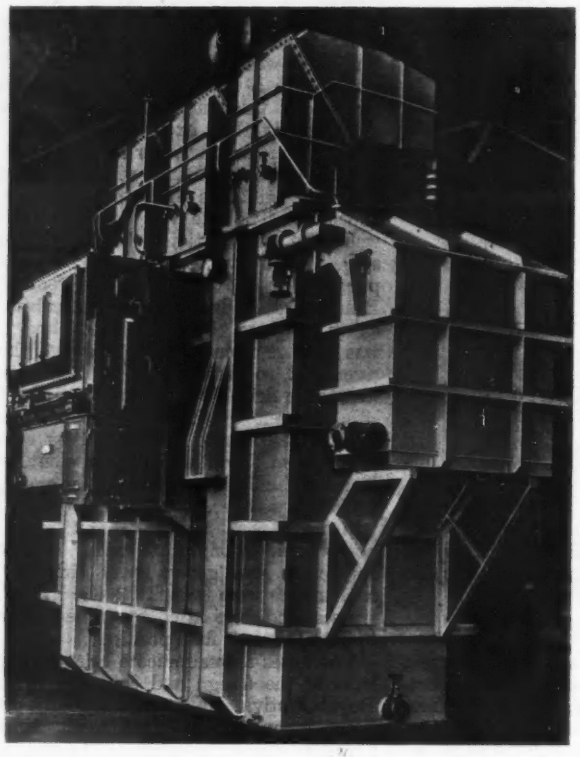
[3] See THE ENGINEER of August 12, 1949, page 171.

[4] Paper No. 5816, "The Design and Construction of the Royal Festival Hall, South Bank," by E. O. Measor and D. H. New, Institution of Civil Engineers, March 13, 1951.

[5] "Construction of the Royal Festival Hall," by E. R. Hole and F. C. Eales, *Journal* of the Institution of Structural Engineers, March, 1951.

88·75MVA Transformers for Barking "C" Generating Station

THE first of three 88·75MVA generator transformers, manufactured by Hackbridge and Hewittic Electric Company, Ltd., for Barking "C" power station (B.E.A., London Division), was recently dispatched to site, the second and third being scheduled for delivery late 1951 and early 1953, respectively. These units, each of which will step up the



88·75MVA GENERATOR TRANSFORMER FOR BARKING "C"

generator voltage of 12·5kV to feed into the 132kV grid system, have single-core 132kV cable sealing ends, instead of the more usual high-voltage porcelain bushings for the outgoing connections. The transformers are three-phase, "OFW" outdoor units, having push-button-controlled on-load tap-changing gear on the high voltage winding, to provide a voltage variation of ±10 per cent in fourteen equal steps. Cooling is by means of water-cooled oil coolers, with submerged motor-driven pumps to provide forced oil circulation.

As shown in the accompanying illustration, the three single-core cable-sealing ends provided for the outgoing high voltage connections are mounted on the tank cover. On the right of the tank is the enclosure housing the midpoint reactor, which operates in conjunction with the on-load tap-changer.

The weight of each transformer, complete with oil (over 9000 gallons) and including the on-load tap changing equipment, water coolers and oil pumps, is nearly 150 tons. The transformer measures 23ft long, 12ft wide and 26ft high, but stripped for transport its height is necessarily reduced to 15ft 3in and its weight to 118 tons. Transport to Barking was made by road over a circuitous route, to avoid low bridges.

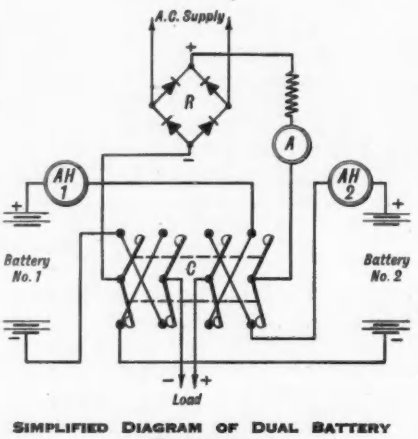
TORONTO TRADE FAIR.—Four companies, British Ropeway Engineering Company, Ltd., Fisher and Ludlow, Ltd., Mavor and Coulson, Ltd., and John Thompson, Ltd., together constitute the British Mechanical Handling Group, which is one of the groups formed to represent British industry at the Canadian International Trade Fair, opening in Toronto on May 28th. The group will show products ranging from conveyors of all descriptions to factory storage equipment and aerial tramways.

Dual Battery Automatic Equipment for Colliery Shaft Signalling

DIRECT current supplies for pit-shaft signalling systems in collieries are normally derived from a floating battery and rectifier. Adjustment of the rectifier output may be carried out manually; alternatively, an automatic constant potential rectifier assembly may be incorporated. In either case a system is recommended whereby the battery normally floats across the rectifier at a voltage equivalent to 2·3V per cell, chiefly to ensure that a fully charged battery is available for use in an emergency, such as mains failure, when the battery would have to supply the load unaided. According to the value of the load the terminal voltage would then be equivalent to a nominal 2V per cell and the normal floating trickle charge of 2·3V per cell might be considered too high for some installations. To allow close voltage limits to be maintained under all conditions the Tudor Accumulator Company, Ltd., 50, Grosvenor Gardens, London, S.W.1, has developed a special dual battery quipment, which is being exhibited for the first time on the company's stand at the British Industries Fair, Castle Bromwich.

This dual battery equipment (illustrated herewith) provides for automatic charge, discharge and battery changeover and the supply system therefore requires a minimum of supervision. The signalling load is supplied at all times by one of two duplicate batteries, the change over from one to the other being made automatically as one battery becomes discharged.

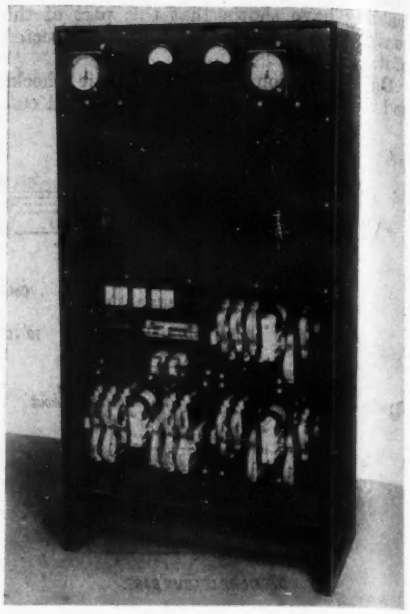
The much simplified diagram reproduced



SIMPLIFIED DIAGRAM OF DUAL BATTERY EQUIPMENT

herewith shows the schematic arrangement of the main components from which it can be seen that one or other of the two batteries is always connected to the load circuit via the automatic changeover contactor *C*. Whilst, say, battery No. 1 is on discharge, battery No. 2 is either being charged from rectifier *R* or, when the charge is completed, is standing by in a fully charged condition ready to take over from battery No. 1 when the latter becomes discharged.

Control of the discharge and charge cut-off points is effected by the recording and actuating ampere-hour meters, AH1 and AH2.



DUAL BATTERY EQUIPMENT

Contacts in these ampere-hour meters operate relay circuits, which in turn operate other contactors not shown in the simplified diagram. Red indicating lamps are also included to show which of the two batteries is on charge and a green lamp to indicate that there is no fault in the contactor coil circuits, whilst alarm relays are also provided to give warning of failure of charge current and of a.c. supply to the rectifiers. Since the cycle of operations is automatic and continuous the only routine maintenance required is the usual topping-up of electrolyte in the cells.

Shipbuilding in Australia

AUSTRALIA, in a relatively modest way, compared with other countries, is playing a useful part in rehabilitating the world's shipping tonnage. A recent instance of such progress was the launching at the State Dockyard, Newcastle (N.S.W.) of a twin-screw motor vessel, built to the order of the Union Steamship Company of New Zealand, Ltd., and to be used for trade between Australia and her sister Dominion. The vessel, "Karoon," of 2500 gross tonnage, has a deadweight capacity of 3000 tons. Her dimensions are: overall length 305ft, beam 43ft and depth to upper deck 19ft 6in. Five sets of derricks serve the three cargo holds and two refrigerated chambers with a total capacity of 1600 cubic feet are provided for the carriage of frozen cargoes from Tasmania. Two 840 b.h.p. Polar Atlas oil engines of the latest design comprise the propelling machinery for the twin propellers and are designed to give a normal speed of 10 knots. All auxiliary machinery, including winches and windlass, are driven by electric motors fed by three six-cylinder 120kW Ruston and Hornsby diesel generators. "Karoon" is the first vessel to be constructed under the Commonwealth Shipbuilding Subsidy of 25 per cent and is built to a design evolved by the Union Steamship Company to meet the needs of its post-war programme. She is the first deep-sea merchantman to be launched by the State Dockyard to the order of an overseas shipping company; hence the name, "Karoon," which, in aboriginal language means "Number One."

Diesel Engine Users' Association

On Thursday, April 19th, the Diesel Engine Users' Association held a luncheon at the Connaught Rooms, London, under the chairmanship of Mr. W. Howes, the immediate past-president. Mr. Howes was deputising for the president, Major-General A. E. Davidson, who, unfortunately, was indisposed. Following the loyal toast, Percy Still medals were presented to Mr. E. W. Johnston, for his secretarial work during the war; Mr. Gerald Fox, for his paper entitled "Factors Affecting Piston Temperature," and to Mr. F. J. Mayor, for his paper entitled "Development in Thames Tugs." The principal guest, Mr. T. A. Crowe, chief engineer of John Brown and Co., Ltd., proposed "The Association" and briefly mentioned the stages in the development of diesel engines, with which he had been associated, the latest being the Doxford opposed-piston oil engine. Turning from the oil engine, Mr. Crowe went on to discuss gas turbines and the progress made in development work. He described the operational cycle of both the open and closed designs and called attention to difficulties which must be overcome before improved thermal efficiencies could be attained. On the question of fuel, Mr. Crowe said that the use of coal banished vanadium troubles but introduced the problem of ash disposal. His company hoped to have a closed cycle gas turbine operating on dried peat fuel at an early date. He mentioned one gas turbine, which had attained a 30 per cent overall thermal efficiency, and added that the experimental turbine at Clydebank had completed 2000 hours' running on boiler oil. It was expected that the 12,500kW gas turbine, which was building for the North of Scotland Hydro-electric Board, would be in service by the end of 1951.

Iron and Steel Institute

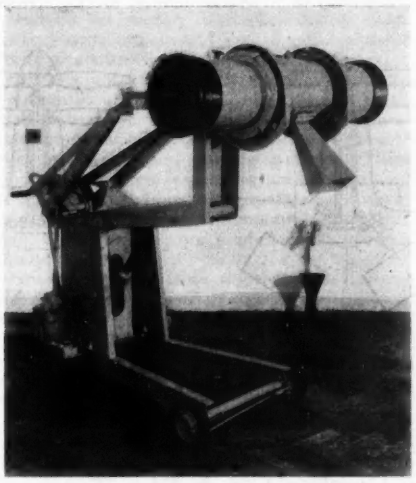
The annual general meeting of the Iron and Steel Institute will be held on Wednesday, Thursday and Friday, May 30th and 31st, and June 1st, at 4, Grosvenor Gardens, London, S.W.1. The first day's proceedings will begin at 10 a.m. with the formal business and presentation of awards and the induction of Mr. Richard Mather as president. After Mr. Mather has delivered his presidential address, Mr. B. Matuschka's paper on "The Present Position of the Converter Process," will be discussed. At the afternoon session, at 2.30 p.m., films are to be shown on "Study of the Zone in Front of a Blast-Furnace Tuyere by means of High-Speed Motion Pictures and Models." They will be followed by discussion of a paper by Dr. J. B. Austin, entitled "Significance of Equilibrium and of Reaction Rate in the Blast-Furnace Process." On Wednesday evening, the Institute's dinner will be held at the Dorchester Hotel, Park Lane, W.1, at 7 p.m. for 7.30 p.m.

At the morning session, on Thursday, May 31st, beginning at 10 a.m., the following papers are to be discussed: "Aspects of the Blast-Furnace Situation in the U.S.A.," by Mr. Owen R. Rice; "Evolution of the All-Carbon Blast-Furnace," by Messrs. J. H. Chesters, G. D. Elliot and J. D. Mackenzie, and "Radioactive Indicators for Blast Furnace Refractory Wear," by Mr. E. W. Voice. At the afternoon session, at 2.30 p.m., there will be joint discussion of papers, as follows: "The Smidth Agglomerating Kiln—Plant and Practice at East Moors Works, Cardiff," by Mr. W. E. Simons; "Sinter Making at Appleby-Frodingham," by Messrs. G. D. Elliot and N. D. Macdonald; "Investigation of the Effects of Controlled Variables on Sinter Quality," by Messrs. E. W. Voice, C. Lang and P. K. Gledhill, and "The Sintering of Northamptonshire Iron Ore," by Messrs. D. W. Gillings, E. W. Voice, C. Lang and P. K. Gledhill.

The final session of the meeting will last from 10 a.m. to 1 p.m. on Friday, June 1st, when there is to be discussion on "Full-Scale Blast-Furnace Trials," by Messrs. J. A. Bond and T. Sanderson, and "Distribution of Materials in the Blast-Furnace," by Mr. R. Wild.

A 200kV Industrial X-Ray Unit

A new design of industrial X-ray unit for non-destructive testing (giving a radiographic penetration of 3in of steel) has been introduced by Philips Industrial, Ltd., Century House, Shaftesbury Avenue, London, W.C.2. As illustrated herewith, the X-ray unit proper is of cylindrical form and is subdivided internally by two insulating partitions. Two transformers, each complete in itself and designed for 100kVp to earth energise the tube. The transformers, and the X-ray tube, which is



200kV Industrial X-Ray Unit

housed in the central compartment, are oil-immersed, the three assemblies being direct connected. An additional filament-heating transformer is provided on the cathode side. The tube, which is continuously rated at 200kVp and 10mA, acts as its own rectifier and there are no valves or high tension cables. The X-ray beam emerges from a window in the wall of the container, the position of the focus being the geometric centre of the aperture. Water-cooling is used for the anode of the X-ray tube and an internal water duct also cools the oil. The control unit is very compact and is designed to facilitate easy transport. Reproducible operating conditions are made possible by means of a mains compensator. A stepless auto-transformer, working in conjunction with a kilovoltmeter, enables the penetration to be controlled with considerable precision. The tube current, which can be varied, is indicated by a milliammeter and a protective circuit prevents the apparatus from being switched on without cooling water; alternatively, it is switched off automatically if for any reason the water supply should be interrupted. Cooling is normally effected from the water main but the makers also offer a trolley mounted closed circuit system for use in the field or where mains water supply cannot be relied upon.

The illustration shows the "Compactix" unit, as it is called, mounted on a truck with hydraulically operated raising and lowering gear, permitting a very wide range of vertical adjustment. For use in shipyards and on outdoor structures, the X-ray head is provided with slings, so that it can be used quite independently of any other form of mounting. For such work the cylindrical form of the tube-head permits of easy passage through a manhole. The equipment is completely shock-proof and suitably X-ray protected and its operation is unaffected by humidity or altitude.

The "Compactix" unit is stated to have a radiographic penetration of 3in of steel in an economical exposure time and is constructed to operate from a single-phase supply 220/250V, 50/60 c/s.

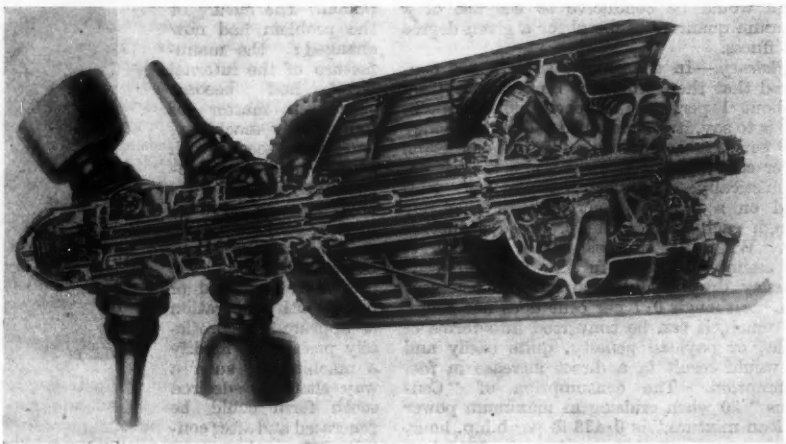
The Twin Centaurus Power Plant for the Bristol "Brabazon"*

By J. L. Norton†

No. II—(*Continued from page 543, April 27th*)

Dual-Reduction Gear

This reduction gear (Fig. 4) is really two separate reduction-gear trains contained in a common case. Originally, it was proposed to couple the two engines together mechanically and to drive a true contra-rotation propeller (Fig. 5). This would have necessitated a clutch in each drive to facilitate starting and to isolate either engine and the clutch would have had to be of such a design that, when engaged, a fixed known angular relationship would exist between the two engine crankshafts. The need for this is dictated by the torsional vibration characteristics of the engine. Furthermore, aircraft engines do not normally need flywheels, since the propellers they drive have a sufficiently high moment of inertia without them. With the true coupled system it would have been necessary to provide a flywheel on each engine to achieve satisfactory starting and running prior to clutch engagement. It was decided to let each engine drive its own propeller independently, and to have no clutches, no flywheels, and no phasing problem. Ways and means were then sought of achieving the most efficient and lightest form of reduction gear.



Perspective section

Fig. 4—*Dual-reduction Gear and Propeller Hubs*

Since the main-drive shafts were to be arranged at an angle, the use of bevel gears

*Abstract. Institution of Mechanical Engineers, April 20th.

†Special Projects Engineer, The Bristol Aeroplane Company, Ltd. (Engine Division).

could not be avoided. From some eight or ten possible lay-outs three probable schemes were evolved :—

(1) A straightforward bevel train for both left-hand and right-hand engines, with a bevel idler interposed between the pinion and wheel of the left-hand train (Fig. 6(*a*)).

(2) A straightforward pair of bevels for both the left-hand and right-hand drives (Fig. 6(*b*)). This system required a virtually new engine on one side with reversed crankshaft rotation. Although this could have been done it would have entailed a large amount of extra work, since a number of new components, including oil pumps, crankshaft, cylinder sleeves, &c., would be required, and the engine would have had to pass numerous tests for approval of basic type.

(3) A simple pair of bevels between the left-hand engine and the inner propeller shaft and a " reverted " or internal bevel and pinion between the right-hand engine and the outer airscrew (Fig. 6(*c*)).

In finally adopting the reverted bevel scheme the following major features were considered.

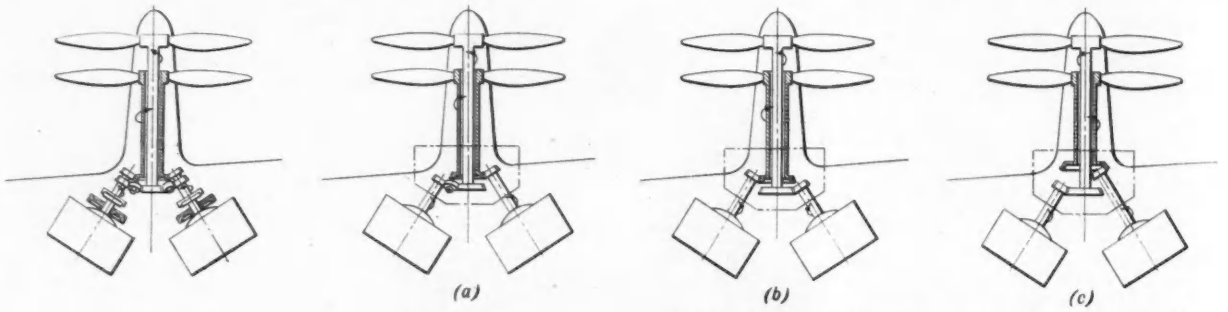
Compactness.—The complete assembly would be more compact with this system, the casing being of a generally circular form without large excrescences other than those housing the two input shafts. The degree of symmetry thus afforded would not only help the foundry in producing sound castings but would also help to ensure symmetrical thermal distribution.

Weight.—The elimination of idlers with their bearings, &c., would result in an appreciable saving in weight and the compact design would be conducive to the use of a minimum quantity of metal for a given degree of stiffness.

Efficiency.—In the early stages it was considered that there would be an efficiency drop of about 1 per cent for each tooth contact. That is to say, it was assumed that an efficiency of 99 per cent would obtain for a pair of gears, 98 per cent for a three-gear train, and so on. Optimistically, however, calculations were based on a 0·7 per cent drop in efficiency through each half of the proposed reduction gear. With the interposition of an idler it was assumed that a further 0·7 per cent efficiency drop would occur in the one gear train. Although 0·7 per cent does not sound very much, it can be converted into terms of weight, or payload penalty, quite easily and this would result in a direct increase in fuel consumption. The consumption of " Centaurus " 20 when cruising at maximum power in " lean mixture," is 0·436 lb per b.h.p. hour, and the power at this condition is 1745 h.p. In a flight time of twelve hours it will be seen that, to cover the suggested efficiency drop on four engines (since only four engines would require the idler), the amount of extra fuel required at take-off would be $1745 \times 0{\cdot}436 \times 4 \times 12 \times 0{\cdot}007 = 256$ lb. which represents more than one passenger with baggage. This quantity of fuel would, however, require extra tankage, which, in turn, would increase the weight.

Heat removed by the oil is dissipated by means of an oil cooler located in the wing and supplied with air from the forward portion of the engine cell. If the heat rejected from one gear train is doubled, then for a given temperature rise the quantity of oil to be circulated also has to be doubled. Furthermore, the capacity of the oil cooler has to be increased, and this can only be done with an oil cooler of greater weight. It has already been estimated that a payload reduction of 1 lb would mean a total revenue loss of about £1000. An efficiency reduction of around 1 per cent would be too expensive to contemplate ; therefore, there was much to be gained by the use of an internal bevel. The production of an internal bevel was, however, a difficulty.

A survey of all available bevel-tooth generating machinery showed that the maximum degree of " reversion " which could be produced was of the order of 8 deg. or 9 deg. Thus, it was not possible to generate involute teeth of an internal bevel gear as required, and some deviation from a generated tooth form was necessary. The degree of curvature of tooth flank was very small and could be changed by variations of pressure angle, and degree of tip-and-root correction. Finally, a tooth form was derived which was almost, but not quite, straight or flat. Since this could still have been produced to the required degree of accuracy only by generation, it was decided to consider the effect of using a completely flat flanked tooth. This proved possible, but it involved some modification to the involute form of the tooth of the mating pinion. The nature of the problem had now changed : the manufacture of the internal bevel had become simply a matter of individually machining flat-sided teeth, with a high degree of accuracy ; the difficulty now was to produce teeth of conjugate form on the mating pinion. From a study of the " Gleason " method of bevel-tooth generation it appeared theoretically possible to modify a machine in such a way that the desired tooth form could be generated and after consultation with gear manufacturers it was decided to proceed with this design.



(*a*) With idler (*b*) With " handed " engine (*c*) With " reverted " bevel

FIG. 5—*True " Coupled Engine " Arrangement.*

FIG. 6—*Dual-reduction Gear Train (Diagrammatic)*

Main Drives and Casings

For the main drives ball or roller bearings are provided for all major shafts. These are housed in aluminium-bronze housings, which, in turn, are shrunk into the casing. All bevel and spur gears are serrated to their shafts and clamped endwise by ring nuts. In the early stages of testing the internal bevel sustained cracking round the hub, due to inadequacy of support, and subsequently it was stiffened and clamped between cones seating on plain parallel parts of the propeller shaft. All nuts securing main gears are tightened to predetermined torques.

All propulsion thrust-loads, plus bevel thrust-loads and a percentage of radial load, are concentrated around the one central boss of the main casing. This boss is located at the apex of the deeply corrugated conical diaphragm structure forming the main body of the casing. The outer periphery of this structure is blended into the strengthened forward part of the casing, which forms the means of attachment to the airframe. This design ensures that the propeller thrust is transmitted through the minimum amount of cast structure and the stresses imposed upon that structure are mainly compressive, thus reducing the chance of fatigue failure.

The mutual loading imposed by the right-hand bevel pinion and the internal bevel produces stresses, which again are compressive and, since the bearings carrying these loads are near together, the deflections are correspondingly small.

The configuration of the assembly of the rear pair of bevels is not quite so favourable but, on the other hand, the bevel thrust is lower and it was possible to straddle-mount the pinion, thus reducing load concentration.

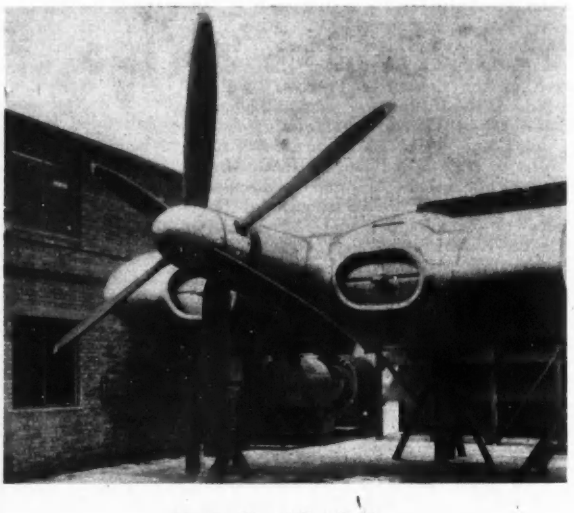


FIG. 7—*Phase 2 Test Stand*

The magnitude of deflections was checked by a series of tests. For these tests the main gear trains were assembled into a casing and both drives were rotated simultaneously at one revolution per minute, while increments of torque up to 100 per cent were applied. Gear deflections were measured by means of many dial indicators contacting through suitable apertures in the casing. The same set-up was used to check bevel-tooth marking under load, during the process of perfecting the gear tooth-cutting technique.

After running the first reduction gear under full-speed maximum-torque conditions, the gear tooth marking surprisingly showed the

same pattern as when loaded to only 50 per cent of maximum torque at the near-zero speed condition used on the rig. This might be due to inertia effects causing the point of maximum wheel deflection to occur just beyond the point of contact. A similar effect can be seen in a polishing shop: when a job is held against the rotating mop, the linen layers separate to a maximum extent some distance beyond the point of contact with the job.

Propeller Shafts

The position of the supports and the distribution of the masses carried, created a problem in obtaining a satisfactorily high whirling speed of the propeller-shaft system. This problem was complicated by the fact that the supports were themselves flexible.

Two schemes were ultimately evolved. The first, with a whirling speed well above the running range, specified an inner propeller shaft of 6in diameter, but required the rear propeller hub to be much larger than the front, with a consequent weight penalty. The second, with a whirling speed somewhat lower, used a shaft of 4·5in diameter but permitted the rear hub to be the same overall size as the front. Furthermore, the shaft bore could be straight and parallel, thus easing manufacture. This scheme was adopted, with the knowledge that a reversion to the heavier scheme could be made later if the need arose.

To prove the calculations, a special rig, known as the "whirling rig," was built. In this, the propeller shafts were carried in and driven by a special gearbox supported in a flight-type of propeller "stalk." The complete unit was fixed to a stiff stand; dummy propellers were secured to the shafts and the rig was driven by a 500 h.p. variable-speed motor. To simulate flight conditions as closely as possible, the dummy propellers were of the same weight and moment of inertia as the flight propellers, and the weight and position of the centre of gravity of the gearbox were also similar to those of the flight reduction gear.

The results of these tests were interpreted with reference to the actual wing flexibilities. Subsequent checks on the Phase 2 test stand (described later) confirmed the general conclusions reached and showed that the amplitude of vibration was within an acceptable limit from the point of view of structure stresses.

Development Testing Programme

As regards power-plant testing, it was estimated that some 1000 hours total running time would be necessary to prove the transmission and other new features. It was expedient to divide this testing into two stages or phases: (1) an exhaustive mechanical test of the reduction gear and transmission system and (2) testing of the complete power plant installation in a form simulating as nearly as possible the flight installation.

Phase I Test Stand.—The simplest way to drive and load the transmission system was to use two "Centaurus" 20 engines and a pair of propellers. A rigid stand was constructed to each side of which an engine was attached. The stand carried a steel plate at the front and the dual-reduction gear, fixed in a robust two-piece steel "stalk," was secured to it. A small water brake was installed for the purpose of loading the accessory drive. Suction fans were arranged behind the engines but these were found later to be unnecessary.

Running commenced in April, 1946, and endurance runs of two and ten hours, respectively, were made, with stripping and inspection of the dual-reduction gear after each. The next test was run to approximately official "type test" conditions and lasted 114 hours. Inspection after strip revealed an extremely gratifying condition of practically all components. Tooth marking was excellent and all bearings were perfect. The only adverse features were cracks in the internal bevel boss and the condition of the freewheel rollers and tracks. Careful measurements of heat rejection were made, with the object of determining the gearbox efficiency. An average figure was 23·5 h.p. at steady take-off condition. Since casing temperatures were low and the casing was protected from the slipstream, an allowance of 25 per cent was thought to be adequate for direct radiation and convection losses. On this basis the mechanical efficiency of the gears was found to be 99½ per cent. Up to the time of writing, some 715 hours of development running have been completed on this test stand.

Phase 2 Test Stand (Fig. 7).—The second phase of the development programme was carried out with the power unit installed in a specially built section of the aeroplane wing. This was fixed on steel supports some 10ft above ground level. Provision was made to introduce additional flexibility in the supporting structure, should this be required later during the vibration investigation.

All services, including fuel and oil systems (except fuel tanks), engine-driven aircraft accessories, &c., were installed. The instrumentation was fairly comprehensive, to provide as complete a picture as possible of air, oil and fuel temperatures, pressures and flows, &c., as well as of cylinder-head temperatures. Strain gauges were fixed to engine mounting members, and vibrographs were installed at critical points.

The first series of tests was begun in November, 1946, and consisted of a complete vibration exploration. The results confirmed expectations following the "whirling rig" tests.

This investigation was followed by endurance runs, during which it was found necessary to strengthen the propeller "stalk" at the cut-away portion round the Hooke's joints in order to avoid fatigue cracking. Certain details of the rib cantilever extension were also found to require strengthening, particularly the ties between main engine mountings.

Engine cooling was found to be completely adequate.

This part of the programme culminated in the official 150 hours "type test." In all, some 415 hours' running have been accomplished on this test stand.

American Engineering News

(From our American Correspondent)

Introduction of Boron-Treated Alloy Steels

Commercial production has now been started on a range of alloy steels treated with boron. The range has been developed by the American steel industry in an effort to conserve three critically scarce alloying elements. The new steels, which are expected to be about 5 to 6 per cent cheaper than the standard grades, which they replace, are designed to curtail the use of nickel, chromium and molybdenum by about 50 per cent. These three alloying elements are now under government restriction. Five companies—The United States Steel Company, the Bethlehem Steel Company, the Youngstown Sheet and Tube Company, the Crucible Steel Company and the Wisconsin Steel Company—have manufactured the initial batches of the new alloys. It is expected that eventually twelve to fifteen steel companies will be producing the range of alloys involved. Boron, which is used to treat the alloys, is an abundant element in the United States and comes principally from the Death Valley of California. The amount of it contained in the various alloys is only 0·002 per cent. It has been announced officially that standard case-hardening grades of all steels can be replaced by one of the new steels of the following chemical composition: 0·17 to 0·23 per cent carbon; 0·45 to 0·65 per cent manganese; 0·15 to 0·35 per cent chromium; 0·20 to 0·40 per cent nickel; 0·08 to 0·15 per cent molybdenum; plus 0·002 per cent boron. Standard full-hardening grades of alloy steel can be replaced by a steel of the following analysis: 0·36 to 0·44 per cent carbon; 0·70 to 1·00 per cent manganese; 0·20 to 0·40 per cent nickel; 0·15 to 0·35 per cent chromium; 0·08 to 0·15 per cent molybdenum; plus 0·002 per cent boron. The heat treatment of the boron-treated steels is essentially the same as that for the standard grades, with the exception that they should be quenched about 75 deg. Fah. higher and tempered about 75 deg. Fah. lower, than the steels they replace.

A Solar Sea Water Still

The U.S.A. spent considerable effort during the war in an endeavour to find ways of producing fresh water from sea water by distillation. Research of this kind was necessary on account of the frequency with which crews of aircraft had been shot or forced down in the Pacific theatre of operations and had had to fend for themselves until rescued. One of the more successful methods then devised was based on evaporating sea water in a solar still. At the recent annual spring meeting of the American Chemical Society, a new still, which produces twice as much fresh water from sea water as any previous large-scale solar still, was described by Dr. Maria Telkes, of the Massachusetts Institute of Technology. This unit consists of a large shallow pan, which is painted black in order to absorb the sun rays. A closely fitting glass roof is built over the black pan, and a channel is provided around the lower edge of the glass roof in the form of a gutter to collect the distilled water. The glass roof is cooled sufficiently by the air and winds to condense the vapour on its inner surface. In the course of an investigation into the reasons for the relatively low efficiencies of earlier solar stills of this kind, it was found that almost half the solar energy received was wasted by the escape of heat into the ground upon which the pan rested. By the use of heat insulation this loss is prevented in the new still, with the result that the water yield has been nearly doubled. It is claimed that in tropical, arid regions, one of the insulated solar stills, covering an area of 1 acre, could evaporate from 10,000 to 12,000 gallons of fresh water daily.

Ocean Freight Terminal at Auckland, New Zealand

The Auckland Harbour Board has announced the award of a joint contract to two American companies and one New Zealand company for the construction of a four-berth ocean freight terminal. The Merritt-Chapman and Scott Corporation and the Raymond Concrete Pile Company, both of New York, will participate in the joint contract with the Fletcher Construction Company, Ltd., of Auckland. The contract is valued at £1,834,789 and provides for the construction of the reinforced concrete substructure and deck of a 1200ft by 300ft pier, including its rail facilities and an inshore steel pile retaining bulkhead. The installation of cargo handling cranes and the construction of pier sheds will be handled under a separate contract. The pier, to be known as Import Wharf, will be built on the last available waterfront site, immediately east of the city's existing piers. It will be of "earthquake-proof" design and will be the first major construction project to be undertaken at Auckland since 1939. Most of the major items of construction equipment involved in the project will be shipped to Auckland from the United States by the two American contractors. The initial consignment will include a steam-operated crane for use at the pile casting yard and a universal pile driver. The latter will be mounted aboard a steel barge to be constructed in New Zealand. Two other steel barges will be built in New Zealand for the handling of piles between the casting yard and the construction site.

Production of Ductile Bismuth

The Fitzpatrick Electric Supply Company, of Muskegon, Michigan, has announced the successful production of ductile bismuth wire and ribbon. This achievement may lead to the development of industrial applications for the metal, which has, so far, not been commercially usable on account of its brittleness and its lack of tensile strength. The company claims to have been able to produce bismuth in a form sufficiently ductile to permit winding a wire on its own diameter at room temperature. Thus, it should become possible to wind coils, transformers and other electrical apparatus without failures. Bismuth is valuable in elec-

trical engineering because its resistance is subject to change in a magnetic field. Furthermore, it is a good "negative" material for use in thermo-couples; furnishing a −69 microvolt change per degree Cent. with platinum over a range from 0 deg. to 100 deg. Cent.

New York City Bus Terminal

The construction has now been completed by the Port of New York Authority of the New York City Bus Terminal, which occupies a full 800ft by 200ft city block bounded by Eighth and Ninth Avenues and 40th and 41st Streets, in mid-town Manhattan. The terminal occupies five levels, has a floor area of over 600,000 square feet and is claimed to be the largest building of its kind in the world. It is designed to accommodate 2500 buses entering and leaving the city each day and to keep them off the congested streets. Initially, its facilities will serve all of the nineteen short-haul bus lines entering mid-town Manhattan and thirteen of the twenty-five long-distance lines. A 3-acre roof parking ramp, with provision for 450 cars, is directly connected with the Lincoln Tunnel Plaza by a 1500ft long overhead ramp. All the four levels and the roof are in part slightly sloped down to minimise the grade along the elevated ramps between the Lincoln tunnel and the third and roof levels of the terminal. The average ramp grade is 3·5 deg., with a maximum of 7·5 deg. on the access ramp to the parking roof. Ice-free operation of the ramps is assured at all times by a radiant heating system embedded in the concrete roadway. The underside of this roadway is protected with insulating board, and some 6 miles of heating pipe coils supply the heat, which comes from the New York Steam Company. The system was designed to melt 1in of snow per hour over a total area of more than 1½ acres. A temperature range of 135 deg. to 175 deg. Fah. is maintained by automatic thermo-couples as well as manual controls. An interesting installation in the long-distance bus area on the lower level of the terminal is a bus detecting system. A control panel shows the situation of all buses in the terminal at any time. Each bus turns on a light on the panel when passing over a treadle while entering its loading berth and again releases the light when it clears the treadle when it departs. On the other hand, the officer in charge of terminal traffic directs incoming buses to berths by flashing numbers on a large screen. Altogether the building contains thirty-one escalators, including one, which moves at the unusual speed of 125ft per minute, intended for travellers in a hurry. In addition to housing the essential activities of the terminal, the building will contain a large number of shops and services for the convenience of travellers. The terminal was planned and designed by the Port of New York Authority and was built at a cost of 24,000,000 dollars by the Turner Construction Company, of New York.

An Atomic Standard of Length

The availability of an ultimate standard of length has been announced by the National Bureau of Standards and the Atomic Energy Commission. The standards consist of spectroscopic lamps containing a single pure isotope of mercury. These lamps enable any organisation possessing the necessary optical interferometry equipment to have an ultimate primary standard of length. The instrument is known as the NBS-Meggers Mercury 198 Lamp and was developed under the direction of Dr. W. F. Meggers, Chief of the National Bureau of Standards Spectroscopy Laboratory. It contains about 1 milligramme of mercury of atomic weight 198, which is obtained by the transmutation of gold in a nuclear chain-reacting pile. In 1931, Dr. Meggers suggested that an ultimate standard of length could be obtained if one of the even atomic weight isotopes of mercury could be isolated from the seven which occur together in natural mercury. At that time no means existed for obtaining useful amounts of a single isotope. In 1945, following the wartime development of the nuclear pile, the production of a sufficient quantity of artificial mercury 198 was achieved at the Oak Ridge National Laboratory by subjecting pure gold to intense neutron bombardment.

Within the spectroscopic lamp, mercury 198 is sealed in a small glass tube and is caused to glow brightly by the application of high-frequency waves. The light waves emitted by the single isotope have extremely sharply defined wavelengths, which can be used for length measurements of great precision. These particular waves are characteristic of the mercury and remain unaltered with time. The new standard of length is based upon the wavelength of the green light emitted by the lamp. This wavelength, approximately 21 micro-inch, is consistently emitted with a reproducibility greater than one part in 1,000,000,000. It is stated that length measurements based upon it can readily be made with an accuracy of one part in 100,000,000. Although the accepted primary standard of length is still the distance between two lines on a metal bar, the majority of precise measurements of length since the beginning of the present century have been made and are likely to continue to be made with the aid of light waves. Up to the present time the wavelength of the red light from cadmium has been used as a wavelength standard. In 1927 the International Conference of Weights and Measures provisionally adopted the value of 1,553,163·13 wavelengths of cadmium red radiation as equal to 1m. In 1948 the National Bureau of Standards proposed that the metre be defined in terms of radiation from mercury 198, a proposal which is now under consideration. Present measurements show that 1,831,249·21 wavelengths of the green radiation from mercury 198 equal 1m. The fundamental advantage of mercury over cadmium is that the wavelengths of the light from mercury are much more sharply defined. Cadmium consists of six principal isotopes which are not separated. They emit light of slightly different wavelengths. When length measurements are made with light having this mixture of wavelengths, a region of confusion results, which limits the accuracy of the determination. Mercury has the advantages of its atoms being heavier, moving about more slowly and hence disturbing the wavelength less. Furthermore, its light can be obtained without heating the metal to a high temperature and thus speeding up the atomic motion. The life of the NBS-Meggers Mercury 198 Lamp appears to be indefinitely long; a lamp under continuous excitation since October, 1949, has shown no significant deterioration after over 10,000 hours of operation. The distribution of the lamps is being handled by the National Bureau of Standards. They will be available to qualified Government, industrial and educational laboratories, both in the United States and abroad, and further information can be obtained from the Co-ordinator of Atomic Energy Projects at the National Bureau of Standards, Washington, 25, D.C.

Technical Reports

Intrinsically Safe Electrical Apparatus: Relation of Igniting Current to Circuit Inductance for Inflammable Mixture with Air of the Vapours of Pentane, Hexane, Heptane and Acetone (Ref. G/T232). By E. M. Guénault, M.Sc., Ph.D., and E. Atherton. The British Electrical and Allied Industries Research Association. Price 4s. 9d. post free.—This report deals with the determination of the mixtures with air of the vapours of pentane, hexane, heptane and acetone most readily ignited by the sparks produced by the rapid interruption of an inductive circuit operated at 24V d.c., and with the relation of igniting currents to circuit inductance for such mixtures. It is found that such mixtures of these vapours are more readily ignited than an 8·3 per cent methane-air mixture. Little difference is found between the ignitibility of pentane, hexane and heptane.

The report forms one of a series on intrinsic safety, earlier reports on E.R.A. investigations being Ref. G/T197 and G/T217. Previous work has been published by the Ministry of Fuel and Power in Safety in Mines Research Papers Nos. 104 and 106 (H.M.S.O.).

French Engineering News

(From our French Correspondent)

The Ponts et Chaussées has in hand a comprehensive programme for improvements of the roads in Tunisia. The department's primary concern at present is the regular maintenance of existing asphaltic surfaces. Tunisia has 5444km of main highways, 2431km of regional roads, and 566km of rural roads. Development and improvement of these roads will be carried out progressively, and the creation of a new network which will form junctions with important highways which are not now directly linked, is envisaged. It is also planned to construct various bridges and other improvements, and to establish on the outskirts of Tunis a network of divergent highways to the south, east and north. The rate at which this programme is carried out will depend upon credits voted for the purpose.

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The Moroccan Railway network to-day stretches over 1690km, of which 718km are electrified. Rolling stock is considerably less than is required to meet the present traffic requirements, as the country is being rapidly industrialised. Various improvements are therefore being undertaken. One of these consists of the construction of a line between Guenfouda and Djerada, the telfer which was used for transporting coal from the Djerada mines to Guenfouda Station having proved insufficient. The railway track will be 45km long and will follow the Metroh Valley. Of this distance, 15km are across extremely difficult country, including great heights and tunnels totalling 4200m in length. A second scheme, the new Casablanca port station, will be officially opened on July 1st.

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The first cars to be built in Morocco are now coming off the production line. They are being built by Georges Irat and have been designed to meet the demands of the country, having 5 h.p. air-cooled engines and five speeds. They have a top speed of 90km per hour, and can turn within a radius of 3m.

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The most important French factory for the production of neon tubes has recently been inaugurated in the Saône-et-Loire district. When in full production the factory will produce 4000km of tubes annually, using 20,000 cubic metres of gas daily.

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The new 130kW hydro-electric plant at Shanghamine, in French Equatorial Africa, has been inaugurated. It will serve local domestic and industrial needs.

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The French Government has agreed to irrigation work in Indo-China, which will bring some 43,000 hectares of land into cultivation. The work will include the rebuilding of pumping stations and hydro-electric plant destroyed by the Indo-Chinese Communists in 1946.

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The original scheme for a thermal power station at Abdijan, in French Occidental Africa, has proved inadequate, and it has now been decided to enlarge the project by the addition of two 2MW sets and two supplementary boilers. The original plan was for two 1MW sets and one 2MW set, with two 300kg, per hour boilers. The latter have already been installed and will soon be in operation, and work on the extension will start shortly.

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The Dunkerque Chamber of Commerce has approved a project for the construction of two floating docks, one of 13,000 tons and one of 1500 tons. Various reconstruction works, including new dockside sheds, is also to be undertaken.

TEXTILE MILL FOR UGANDA.—The Colonial Office states that work has begun on the construction of a textile factory at Jinja, Uganda. The factory, which will utilise power to be provided by the Jinja hydro-electric scheme, will give employment to between 5000 and 6000 Africans. It is expected that it will come into production in about two years' time.

Industrial and Labour Notes

Steel Production and Raw Materials Supplies

In answer to a question in Parliament on Monday last, the Minister of Supply, Mr. G. R. Strauss, made a statement on the prospects for steel production and supplies this year. He said that, during the last quarter of 1950, the iron and steel industry reduced its stocks of imported iron ore by 327,000 tons, pig iron by 20,000 tons, and scrap by 195,000 tons, all of which was equivalent to a steel ingot production of over 400,000 tons. That meant that, of the 1950 steel output of 16,300,000 tons, about 15,900,000 tons were produced from raw materials obtained during the year and over 400,000 tons by reduction of stocks.

In the first quarter of this year, Mr. Strauss continued, further reductions in stocks of imported iron ore, pig iron and scrap, equivalent to a steel ingot production of over 500,000 tons, were made by the industry, so that during the last six months about 1,000,000 tons of its stock of steel-making raw materials had been used up. That source of supply would not, therefore, be available for the rest of this year, as stocks had now been reduced to a dangerously low level, and some furnaces had already had to be closed or damped down. The intake of raw materials which, as distinct from the use of stocks, accounted for an output of about 15,900,000 ingot tons in 1950, included an import of scrap, mainly from Germany, of over 1,900,000 tons. Although efforts were being made to obtain maximum supplies from Germany, there was, Mr. Strauss said, no prospect of attaining anything like that figure this year. It was hoped, however, that there would be some slight improvement in the import of iron ore which had been reduced in the last six months by shipping difficulties; some small increase in the import of pig iron; some increase in the use of home ore, which, however, because of its lower iron content, reduced output per blast-furnace, and, most important, some increase in home scrap supplies. The success of the home scrap drive, the Minister emphasised, was of supreme importance, and unsparing efforts must be made during the coming months to recover every possible ton.

But those factors, Mr. Strauss concluded, even at best, could only offset part of the deficiency. In view of that and the exhaustion of reserve stocks which could be drawn upon, it was evident that steel production this year would be lower than last year. The greatest ingenuity on the part of manufacturers would be needed to overcome the shortage of steel.

Trade Disputes

According to the *Ministry of Labour Gazette*, there were 150 stoppages of work, through industrial disputes, in progress in the United Kingdom during March. Altogether, 34,900 workers were involved in them, with an aggregate loss of 143,000 working days. Of these stoppages, eighty-nine occurred in the coal-mining industry, affecting 7900 workers and causing an aggregate loss of 15,000 working days. In the first three months of this year there were 384 stoppages of work through industrial disputes, involving 96,000 workers and resulting in a loss of 560,000 working days.

Changes in Wage Rates

The Ministry of Labour reports that, in the industries covered by its statistics, changes in wage rates, which came into operation in the United Kingdom during March, resulted in an aggregate increase of about £717,000 in the weekly full-time wages of 1,890,000 workpeople. Among workers included in the increase were those employed in the building industry, civil engineering construction, the iron and steel industry, and time-workers and piece-workers in railway workshops.

In the building industry and civil engineering construction, there was an increase of 2½d. an hour for craftsmen and labourers, and in the iron and steel industry there were increases payable under sliding-scale arrangements based on the index of retail prices. In railway workshops the existing additions to base rates were increased by 10s. a week for men on time-work in craft grades, by 8s. 6d., 9s. or 10s., according to occupation, for men in other grades, and by 5s., 5s. 6d., or 6s. for women. Piece-workers were given flat-rate increases equivalent to those payable to time-workers. All these increases, which were agreed in March, were retrospective to the beginning of January.

In the first three months of this year changes in wage rates have resulted in an aggregate increase of £1,858,800 in the weekly wages of 4,835,000 workers. In the corresponding months of 1950 there was a net increase of £317,000 in the weekly full-time wages of 1,998,000 workers.

Aluminium From Canada

The Ministry of Supply has announced that the principles of a new agreement have been settled with the Aluminum Company of Canada, to ensure increased supplies of aluminium to the United Kingdom. Under this agreement the British Government will make a loan to the company of 40,000,000 dollars towards the financing of expansions, which will increase the company's total productive capacity to 550,000 metric tons.

In return, the quantities of metal to be delivered to this country, under the Ministry's existing contract with the Aluminum Company of Canada, will be increased by 30,000 metric tons in 1952 and 40,000 metric tons in 1953, making the total deliveries in those years 250,000 metric tons and 260,000 metric tons, respectively. The agreement will also provide that the Ministry's first call on 200,000 metric tons per annum of the company's production for twenty years from 1951 shall be supplemented by a further 50,000 metric tons for twenty years from 1954 and that a contract shall be entered into forthwith to exercise the combined first call on 250,000 metric tons per annum in the years 1954 and 1955.

Sulphur and Sulphuric Acid

At the end of last week, the Board of Trade announced detailed allocation schemes for the distribution to industry of sulphur and sulphuric acid in order to provide the most effective use of those commodities in the national interest. The schemes, which operated from May 1st, are based on a consumption of sulphur at the rate of approximately 100,000 tons a quarter.

This means that, in general, users will receive supplies varying between 80 and 90 per cent of their total 1950 consumption. In the case of the superphosphate industry, however, the quantity of sulphuric acid allowed remains at the present level of approximately two-thirds of capacity. Key industries such as iron and steel, explosives, metal extraction, tinplate and certain oil-refining processes are to be maintained at full output, including output from new capacity. Full production of essential food and health services is also to be maintained.

The Board says that when the allocation schemes are in full operation, no consumer should receive either less sulphur or sulphuric acid than he has had since the beginning of this year. It is emphasised, however, that some short period must elapse before the schemes can be fully effective.

Lead Allocations

The Ministry of Supply has stated this week that, although the lead allocation for May remains unchanged at 90 per cent of the 1950 average monthly consumption and consumers may buy up to that amount, deliveries may be delayed during this month because of temporary difficulties over shipping. The Ministry expects to be able to deliver at least 80 per cent of the 1950 monthly average consumption. The balance of 10 per cent, it says, if it cannot be delivered in May, will be delivered in June in addition to that month's quota.

Manpower Problems

The National Joint Advisory Council, which includes representatives of the British Employers' Confederation and the Trades Union Congress and the nationalised industries, held its quarterly meeting in London last week under the chairmanship of the Minister of Labour, Mr. Robens. An official statement issued after it said the Council once more reviewed the manpower problems arising from the rearmament programme, bearing in mind the need to maintain exports and check inflation. Attention was directed to the increasing shortage of skilled workers and to the importance of meeting that difficulty by methods of training, upgrading and dilution. It was agreed that the Minister of Labour should send a communication on the matter to all joint industrial councils and similar bodies in terms which are to be settled with both sides of the Advisory Council.

Raw Material Supplies

The annual general meeting of the London Chamber of Commerce was held on Thursday of last week, and in the course of his presidential address, Sir Frank Nixon referred to the fact that the greatest commercial anxieties to-day centred round questions of the production and distribution of raw materials. It was, he said, beyond doubt that the intervention of Governments, whether as sole buyers, as operators of rationing schemes, or merely as somewhat ineffective and disgruntled observers, had confused the raw materials situation. But there was also observable a steady change in the position of the main commodities.

Normal demand, Sir Frank observed, was steadily overhauling and sometimes already outstripping supply. The steady and considerable growth in the world's population, the great and continued development of their own industries by countries which had been until recently almost exclusively agricultural, the constant increase of mechanisation and elaboration of industrial processes, the steady augmentation amounting to several per cent per annum in the productivity of the industrial countries, and, above all, the phenomenal increase in American industry were all trends which demanded more and more raw materials. They were trends of an enduring character which would persist when stock-piling and even rearmament were completed. Rearmament, Sir Frank agreed, would indeed intensify the permanent demand for most raw materials, since it was the avowed purpose of the United States rearmament programme not only to increase production during the next three years by nearly as much as the country's total production prior to 1939, but to maintain that vastly augmented capacity as a base line from which American industry would again resume its normal annual expansion.

It seemed, therefore, Sir Frank continued, that the commodity problems were no ephemeral problems caused by stock piling and rearmament. On the contrary, the indications were that the industrial conquest of nature had reached, or was reaching, another of its major turning points, and that the abundant supply of raw materials which grew up all over the world during the nineteenth century, mainly in response to British initiative, could no longer be relied upon. He suggested that we were entering on a period, and probably a long period, when the economic problems and policies of the great nations would be increasingly influenced and maybe dominated by the need to ensure the production and distribution of adequate supplies of commodities at reasonable prices or to find suitable substitutes for them.

Notes and Memoranda

Rail and Road

GLOUCESTER–BRISTOL TRUNK ROAD.—The Minister of Transport has recently received a deputation representing the Gloucestershire County Council, the Bristol, Cheltenham and Gloucester Corporations, the Port of Bristol Authority and the Birmingham and Bristol Chambers of Commerce, which stressed the urgent problem of congestion and road dangers on the Gloucester–Bristol trunk road. The Minister was asked to consider representations that authority should be given at the earliest possible date to relieve those conditions by permitting a start to be made on the scheme for widening the carriageway throughout this length of road to 30ft. He was also asked to honour the undertaking that he had given, when the Filton by-pass was closed, to provide an alternative route. The Minister acknowledged the importance of carrying out improvements on the trunk road, but emphasised the difficulty confronting him through the very severe restriction of the funds at his disposal. As regards the alternative route to the Filton by-pass, he pointed out the importance of avoiding any unnecessary capital expenditure in present circumstances.

Air and Water

THE ALVIS LEONIDES ENGINE.—A substantial order has been placed for the Alvis Leonides piston engine by the Ministry of Supply. Nine separate types of British aircraft are fitted with this engine, of which there are six marks, each developing between 400 h.p. and 500 h.p. The Leonides is now also the standard British "vertical" engine for use with helicopters.

AIRCRAFT ENGINES.—Two new power plants for aircraft have been announced. The Napier "Nomad" is the first British turbo-piston engine. The main advantage of this form of composite engine is the low fuel consumption obtained. It combines a highly supercharged piston engine and a gas turbine, the former supplying the turbine with the products of combustion, thereby dispensing with the radial compressor and static combustion chambers. The Bristol "Olympus" is stated to be a large turbo-jet engine with a particularly low fuel consumption. Two new versions of the de Havilland "Ghost" turbo-jet engine have also been announced and are numbered the D.Gt.4 and 5.

Miscellanea

HIGHER MANAGEMENT LECTURES.—The London Centre of the Institute of Industrial Administration is arranging its tenth series of higher management lectures. They will be delivered on Wednesday evenings at 6.30 p.m., from May 16th to June 13th, in the Fyvie Hall of the Polytechnic, Regent Street, W.1, and will deal with "The Tools of Management—Planning and Control." The fee for the course is one guinea. Particulars can be obtained from Mr. W. T. Pope, 44, Horn Park Lane, London, S.E.12.

ATOMIC ENERGY CONFERENCE.—Representatives from the British, Canadian and American atomic energy projects have begun a fortnight's conference at Harwell to discuss instruments used in their work. The first week's agenda has been devoted solely to technical discussions and during next week visits are to be made to British instrument manufacturers. This is the third international conference of its kind, and the United Kingdom delegation is led by Mr. Denis Taylor, head of the electronics division at Harwell.

PRESTRESSED CONCRETE STRUCTURES.—The Cement and Concrete Association is organising a symposium on prestressed concrete continuous and framed structures to be held at the Institution of Structural Engineers on September 24th and 25th next. The dates have been arranged in order that overseas visitors attending the Building Research Congress may have an opportunity of taking part. The Cement and Concrete Association, 52, Grosvenor Gardens, London, S.W.1, will be pleased to supply copies of the programme to any readers who are interested.

THE ALUMINIUM DEVELOPMENT ASSOCIATION.—At the annual general meeting of the Aluminium Development Association, held on April 20, 1951, Mr. Austyn Reynolds, B.A., was elected president, in succession to Mr. Edward Player. Mr. Reynolds, who is a director of Tube Investments, Ltd., and deputy chairman of T.I. Aluminium, Ltd., has been a member of council for six years and vice-president during 1950/51. Mr. H. G. Herrington, of High Duty Alloys, Ltd., is the new vice-president, and Mr. F. G. Woollard, M.B.E., was again elected chairman of the Executive Committee.

OIL REFINERY PROGRESS FILM.—The construction of the great oil refinery at Fawley, near Southampton, which is being built for the Esso Petroleum Company, Ltd., has been filmed, stage by stage. The first part of the film was shown in October last year and covered the initial stages of the work, such as site clearance, laying of foundations and early building operations. Work carried out up to the end of 1950 forms the subject of the second part of the film, which is now ready. This film records the spectacular stages of construction such as the erection of the main refinery units, debutaniser tower and also the laying of pipe tracks, the oil jetty under construction, the social amenities and the planting of the screening tree belt.

O.E.E.C. EQUIPMENT MISSION.—A group of European experts has left for the United States for a six-weeks' study of American equipment for materials handling. This mission, which has been arranged under the technical assistance scheme of the Organisation for European Economic Co-operation, will study the latest means of increasindustrial productivity by reducing to a minimum the various operations within the factory such as loading, unloading, stacking and reloading. Its members will also study questions of standardisation, large-scale production, accessories and ancillary devices, and equipment for handling operations of a particularly difficult nature. In addition, the application of various classes of equipment in selected industries, and the economic consequences on production and productivity, will be examined during the tour.

LONDON TRUNK TELEPHONE EXCHANGE.—On April 30th, the Postmaster General, Mr. Ness Edwards, opened a new trunk telephone exchange at Judd Street, London, W.C.1. The new exchange, known as Trunk Control North, controls demand trunk calls from subscribers on certain London exchanges. It is part of a scheme for decentralising the control of trunk traffic and will relieve Faraday Building, which was originally the control centre for all trunk calls originating in the London area. At present only forty switchboard positions are in service, but they will be increased by stages to two 150 switchboard position units, planned to be in operation in the summer of 1952. In addition to the telephone exchange, the new building will later accommodate automatic teleprinter switching equipment, part of the national network, which will serve teleprinter offices in Central London.

A DINNER OCCASION.—On Monday, April 30th, a dinner was given by Mr. A. P. Good, chairman, The British Oilfield Equipment Company, Ltd., at the Dorchester Hotel, London, on the occasion of a visit to Great Britain of Mr. J. S. Abercrombie, president, and Mr. Herbert Allen, vice-president of the Cameron Ironworks, Houston, Texas, and in honour of the members of the Corps Diplomatique accredited to the Court of St. James. After the loyal toast had been honoured, Sir Ronald Matthews proposed the toast of "The Members of the Corps Diplomatique," to which Mr. Krishna Menon, High Commissioner for India, and Dr. Subandrio, the Indonesian Ambassador, replied. Mr. Good then proposed the toast of his guests and Mr. Herbert Allen replied. Sir Archibald Rowlands, Permanent Secretary to the Ministry of Supply, also replied. The toast list was concluded when Mr. Edward Benjamin, managing director, British Oilfield Equipment Company, replied to a toast of that company, proposed by Lieut.Colonel S. J. M. Auld. The entertainment was continued by a cabaret show.

BIRMINGHAM UNIVERSITY.—A graduate school of thermodynamics and related studies has been established in the Department of Mechanical Engineering of the University of Birmingham. It has been designed to meet the need of certain sections of the engineering industry for a supply of men trained to a standard higher than that of a normal degree course and to give opportunity for the study of advanced techniques and modern developments in the general field of the heat engine. The courses, comparable in standard with the M.Sc., will begin on October 2nd, and are available to candidates who have a degree in engineering or satisfactory alternative qualifications, together with suitable practical engineering and experience. Applications from graduates in other sciences will be considered in the light of the applicants' qualifications and experience. The basic course, leading to the award of the Diploma of Graduate Studies, will occupy one academic year but variations both in the content of the course and its duration will be made where advisable to suit the needs of individual students. The inclusive fee for the basic course is £70 and all particulars may be obtained from the Registrar, The University, Edgbaston, Birmingham, 15.

Personal and Business

MULLARD, Ltd., is the new title of the company hitherto known as Mullard Electronic Products, Ltd.

PHILIPS BLACKBURN WORKS, Ltd., Blackburn, Lancs, states that it will be known in future as Mullard Blackburn Works, Ltd.

MR. ERIC G. YARROW informs us that his home address is now "Bemersyde," Lochwinnoch Road, Kilmacolm, Renfrewshire (telephone, Kilmacolm 183).

NEWMAN INDUSTRIES, Ltd., Yate, Bristol, has been appointed sole selling agent for the United Kingdom for Heid centre lathes and copying lathes.

THE NATIONAL COAL BOARD announces that Sir Herbert Hutchinson is retiring from the secretaryship at the end of July. He is to be succeeded by Mr. C. A. Roberts, C.B.E.

MR. W. E. BUDDING, assistant commercial manager of the British Electricity Authority, is retiring at the end of this month after fifty years' service in the electricity supply industry.

MR. H. D. BELL, having taken up permanent residence abroad, has resigned from the board of Aberdare Cables, Ltd. Mr. J. P. Gilliver and Mr. A. J. Nicholas have been appointed to the board.

SIEMENS-SCHUCKERT (GREAT BRITAIN), Ltd., Faraday Works, Great West Road, Brentford, announces the appointment of Mr. J. D. Morton, M.I.Mech.E., M.I.E.E., as sales and technical manager.

ROLLS-ROYCE, Ltd., announces the appointment of Mr. A. G. Elliott as joint managing director with Lord Hives, C.H. Mr. Elliott joined the company in 1912, was appointed chief engineer in 1937 and a director in March, 1945.

MR. D. MAXWELL BUIST, M.I.E.E., export director of BEAMA, has been elected chairman of the council of the Institute of Export. Mr. J. P. Ford, director and general manager of Associated British Oil Engines (Export), Ltd., has been elected vice-chairman.

DR. W. L. LOWE-BROWN, D.Eng., M.I.C.E., M.Am.Soc.C.E., informs us that he has retired from the firm of Sir Murdoch MacDonald and Partners. He will continue to practise from his new offices at 39, Victoria Street, Westminster, London, S.W.1. Telephone number, Abbey 4150.

WALTER'S ELECTRICAL MANUFACTURING COMPANY, Ltd., Kensal Road, London, W.10, states that Mr. Harold Parker, A.I.E.E., has been appointed managing director, in succession to Mr. E. E. Moore. Mr. Moore, who has been in the company's service for over fifty years, has now been appointed chairman.

INSLEY (LONDON), Ltd., 119, Oxford Street, W.1, has been appointed sole distributor in the United Kingdom and British Commonwealth for Hydrel needle bearings, manufactured by Hydrel A.G., Romanshorn, Switzerland. The company has also been appointed an agent for KFA Kugellager-Fabrik Arbon A.G., Swiss bearing manufacturers.

MR. EDWARD HIRST has resigned his positions of vice-chairman and joint managing director of the British General Electric Company, Pty., Ltd., owing to ill health. He will continue to serve as a director of the company, which is the Australian associate of The General Electric Company, Ltd. Sir Harry Brown will continue as chairman and Mr. W. R. Caithness and Mr. T. E. Morgan have been appointed joint managing directors.

Launches and Trial Trips

BRITISH PIONEER, motor tanker; built by the Blythswood Shipbuilding Company, Ltd., for the British Tanker Company, Ltd.; length between perpendiculars 463ft, breadth 61ft 6in, depth moulded 34ft, deadweight 12,500 tons; Kincaid-Burmeister and Wain four-cycle, single-acting diesel engine, six cylinders, 740mm diameter by 1500mm stroke, 3200 b.h.p. Launch, April 24th.

REGENT CARIBOU, motor tanker; built by the Blythswood Shipbuilding Company, Ltd., for the Bowring Steamship Company, Ltd.; length between perpendiculars 516ft, breadth 70ft 6in, depth moulded 38ft, deadweight 17,600 tons, thirty cargo oil tanks, two pump rooms, four cargo oil pumps; Rowan-Doxford two-stroke, airless injection oil engine, five cylinders, 670mm diameter by 2320mm combined stroke, 5600 b.h.p., heavy oil fuel, two single-ended return-tube boilers. Trial, April 26th.

British Patent Specifications

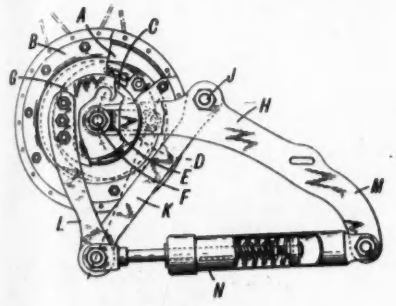
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

AUTOMOBILE ENGINEERING

651,533. April 13, 1948.—Suspension of Road Vehicles, Arthur Taprell Clark, of 22, Windermere Avenue, Morden, London, S.W.19.

The invention relates to a spring suspension for vehicle wheels or for means supporting endless tracks, and particularly relates to spring suspensions for the rear wheels of motor cycles, as shown in the accompanying drawing. The hub *A* of the wheel has on each side a cover plate *B* which forms a housing for a ball race by which a two-part drum *C* is supported. The inside of the drum is provided with a recess *D* in which one end of a link *E* is pivotally mounted. The other end of the link is of considerable width and is provided with bearings through which extends a spindle *F* fixed to the usual back forks of the bicycle. The length of the link *E* is such that during the relative swinging movement between it and the drum, the end of the link carrying the spindle may become coaxial with the drum. The ends of the drum end plates *G* are provided with arcuate slots through which the ends of the spindle extend and are secured to the fork of the bicycle frame. Arranged on the outside of one of the limbs of the fork is a fixed link *H*, one end of which is drilled to engage the spindle



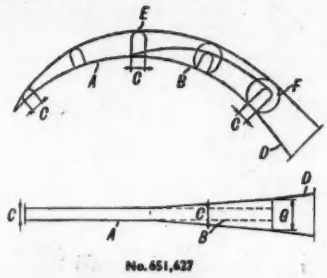
No. 651,533

F, while another part is provided with means for attaching it to the frame. Between the spindle and the point of attachment the fixed link has a pivot pin *J* which engages the upper end of a downwardly inclined link *K*, the lower end of which is pivotally attached to an arm *L* rigidly fixed to one of the end plates *G*. A closed pivoted link system is thus provided by the drum and arm, which constitute one link, and the links *E*, *H* and *K*. The longitudinal axis of the first link may be represented by the dotted line shown, and it will be noted all the links extend to the right of the line joining the spindle and pivot pin. The fixed link is provided with a downward extension *M*, which forms a fixed anchorage for the attachment of one end of a spring device *N*, the other end of which is pivoted to the pivot pin. The general proportions of the links shown in the drawing results in the hub moving in a path which, within certain limits, is arcuate and thus the hub can be constrained to move along an arc having its centre at or near the axis of rotation of the driving sprocket. The lengths and dispositions of the links are so chosen that the rate of the deflection of spring due to road shocks will increase and thus road shocks are more readily absorbed. Alternatively or additionally, the linkage is so arranged that the rate of deflection of the spring decreases with increase of the dead load of the system, and thus the characteristics of the spring system with regard to absorption of road shocks are little effected by alteration of the dead load.—*April* 4, 1951.

COMPRESSORS

651,627. October 15, 1948.—Centrifugal Blowers, Maschinenfabrik Oerlikon, of Oerlikon, near Zürich, Switzerland.

In the drawing the volute chamber consists of the two parts *A* and *B*, in which there is no substantial widening of cross-section, the width *C* remains constant. The delivery medium flows out of the part *B* direct into the diffuser *D*; this part of the delivery medium therefore suffers no losses of velocity in consequence of widening. The extension of *A* encloses the part *B*. The outer parts of the cross-section is traversed by the delivery medium of part *A*, and the transition from the rectangular cross-section *E* to the round cross-section *F* takes place gradually over the entire length of part *B*; the widening angles therefore do not exceed 6 deg. The plan view of the volute chamber shows that the delivery medium flows over the width *C* over the entire length into the volute chamber, which, however, has the same width *C* over the length of part *A*. In the extension



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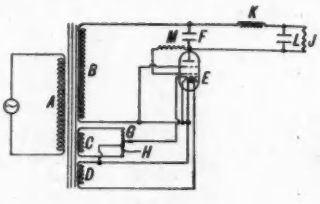
the chamber widens to the width *G*. The velocity at the diffuser inlet is greater in the design of the present invention than in the conventional design and hence more velocity is converted into pressure in the diffuser *D* with greater efficiency, which contributes to the raising of the overall efficiency.—*April* 4, 1951.

ELECTRICAL ENGINEERING

651,583. July 23, 1948.—Rectifying Arrangements for Supplying a Resistive Load, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and Charles Edington Williams, of Research Laboratories of The General Electric Company, Ltd., Wembley, Middlesex.

In the drawing a source of a.c. supply of constant voltage is connected across the primary *A* of a transformer having three secondary windings *B*, *C* and *D*, of which *A* is a main winding for supplying the charge current of the reservoir condenser *F*, a control voltage winding for deriving the grid control voltage, and *C* is a winding for supplying the cathode heater of a thermionic valve *E*, shown as a pentode, which has an indirectly heated cathode. The control grid of the valve is connected to a variable tapping *G* on a potentiometer resistance *H*. Across the reservoir condenser *F* is



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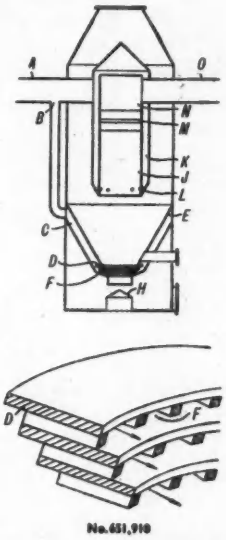
connected the load resistance *J*, and a filter circuit consisting of a series inductor *K* and parallel condenser *L* is connected between the condenser *F* and load *J* for preventing oscillations of the supply frequency from reaching the load. The suppressor grid of the valve *E* is connected to the cathode and the screen grid of the valve is connected to the anode through a biasing resistor *M*. In the operation of this arrangement, with a fixed setting of the control grid tapping *G* on the potentiometer resistor, the reservoir condenser is charged up until a steady state is reached in which the charge fed to the condenser through the valve in each positive half cycle of the a.c. supply voltage just compensates for the current drawn from the condenser by the load during the whole cycle. By adjustment of control grid tapping the amplitude of the alternating control voltage, which is always either in phase or antiphase relative to the supply voltage, can be altered in magnitude, and also in sign, so as to increase or decrease the charge fed to the condenser during each positive half cycle of the a.c. supply voltage and hence increase or decrease the d.c. voltage set up across the condenser *F*, with consequent increase or decrease in the current taken by the load.—*April* 4, 1951.

GAS TURBINES

651,910. May 26, 1948.—Coal-fired Combustion Apparatus for Gas Turbines, Maschinenfabrik, Oerlikon, of Oerlikon, near Zürich, Switzerland.

The invention contemplates separating the supplies of air for the gasification and of air for the combustion of the gases. In the accompanying drawings, air enters through a conduit *A*. The portion of the air which is needed for gasification is diverted at the point *B*. At first the diverted air passes into a funnel-shaped jacket *C*, through to the grate *D*, while cooling the sheet metal casing of a hopper *E*. This air passes through slits *F* in the grate into the layer of fuel, where it effects the coking and gasification of the coal. A core zone is thus formed, which supplies the heat and in which the slag is formed. As shown in the lower view, the grate consists of a series of superimposed rings of increasing diameter spaced apart by distance pieces. The bottom of the grate is normally closed by a member *H*, which is movable vertically to permit the discharge of ash and clinker from the grate. During the gasification process a part of the coal is first burned to form CO_2. In the layer of coal lying above, the CO_2 reacts with the carbon and is converted into CO. For this reaction there must be a relatively thick layer of coal on the grate, so that the coal will at the same time act as a filter to retain the flue dust. Owing to the fact that only that part of the air which is needed for the gasification has to pass through the coal, the rate of flow is lower than if the whole of the air had to pass through the coal. The amount of coal and ash whirled up is thus also reduced. The gases pass almost free of dust into the combustion space. The main



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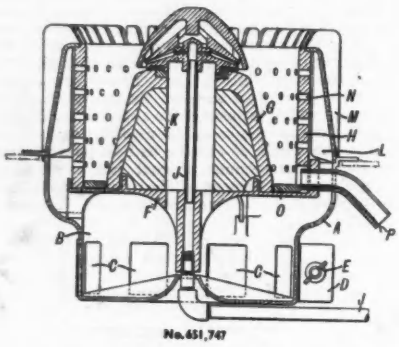
air from the conduit *A* passes into a double-walled jacket *K* surrounding the combustion space *J*. There it is divided once again. A small portion flows in the jacket *K* to nozzles *L* and in so doing cools the walls of the combustion space and impinges on the rising combustion gases and eddies through them. The combustion gases mix with this fresh air and thus receive the oxygen for complete combustion. The remainder of the air passes through conduit *M* to a mixing chamber *N*, where it is mixed with the combustion gases for the purpose of lowering its temperature. From the mixing chamber the mixture passes through a conduit *O* to the consumer. The coal is fed from above through the top aperture and passes through an annular space on to the hopper *E*. The jacketed combustion space is thus additionally surrounded by coal, which acts as heat insulation. The coal is heated and, in the lower part, is coked before passing on to the grate *D*, where it is gasified.—*April* 11, 1951.

BURNERS AND SPRAYERS

651,747. February 26, 1948.—Oil Burners, The Anglo-Iranian Oil Company, Ltd., of Britannic House, Finsbury Circus, London, E.C.2, and John Tyers and Graham Francis James Murray, of the company's address.

The invention relates to oil burners and more particularly to those for the combustion of light and/or heavy distillate oils and/or residue fuel oils. Referring to the drawing, the burner comprises an outer shell *A* having in the lower part formed as an inlet chamber or zone *B*, a number of ports *C*, which may be uncovered as required by adjustment of a ported sleeve *D*, held stationary by a butterfly nut *E*. A circular cast plate *F* is mounted within the casing above the air inlet chamber and supports, in a stationary position by means of a projecting annular ring, a refractory cone *G*, and a cylindrical wall *H* made of a refractory material and surrounding the cone. A fuel inlet pipe *J* enters the casing at the bottom and passes vertically upwards through the centre of the cone. A layer of heat insulating substance *K* fits closely within the cone to leave a central vertical passage surrounding the pipe *J*. A number of air passages provided in the casting connect the air distribution zone in the lower part of the burner casing with the passage. A distributor head is screwed on

the head of the feed pipe and consists of a casting having a circular base, which rests upon an annular heat-resistant washer carried in an annular cavity on the top face of the refractory cone. An annular air preheating zone *L* is formed at the upper part of the outer shell between the outer surface of the cylindrical wall and an upper conical shell. Radial fins *M* extend through the shell and overlap the combustion zone at their upper ends, whereby heat is conducted from the combustion zone to the annular pre-heating zone *L*. The cylindrical wall has a number of transverse air inlet passages *N*



to cause the entering air to create a swirling or turbulence in the combustion zone. The floor of the combustion zone is formed by the surface of the casting *F* and provides an annular trough in which unburned fuel is collected. An overflow pipe passes it out of the burner casing. A ring wick *O* of heat-resistant material is provided to lie within the trough and a string *P* to it passes through the overflow pipe for lighting the burner. —*April* 11, 1951.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Mon., May 7th.—LEEDS BRANCH: Great Northern Hotel, Wellington Street, Leeds, 1, "Engineering Insurance," 7.30 p.m.

Tues., May 8th.—BOLTON BRANCH: York Cafe, Great Moor Street, Bolton, "Approach to Electronics in their Application to Industry," F. E. Noakes, 7.15 p.m.

Wed., May 9th.—BIRMINGHAM BRANCH: Chamber of Commerce, New Street, Birmingham, "Centrifugal Pumps," 7 p.m.——BRADFORD BRANCH: Midland Hotel, Bradford, "The Protection of Overhead Lines Against Bad Weather," F. Lister, 7.30 p.m.

Fri., May 11th.—CREWE BRANCH: Crewe Arms Hotel, Crewe, "Motors and Control Gear," 7.30 p.m.

British Institution of Radio Engineers

To-day, May 4th.—MERSEYSIDE SECTION: Electricity Service Centre, Whitechapel, Liverpool, Annual General Meeting, Film, "Atomic Physics," 7 p.m.

Illuminating Engineering Society

Tues, May 8th.—Royal Institution, Albemarle Street, London, W.1, "Luminescence," E. N. da C. Andrade, 6 p.m.

Institute of Economic Engineering

To-day, May 4th.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, Open Discussion, 7.30 p.m.

Institute of Industrial Supervisors

Tues., May 8th.—DUDLEY AND DISTRICT SECTION: Technical College, Dudley, "Some Impressions of American Production," H. Davies, 7.30 p.m.

Wed., May 9th.—WEST BROMWICH SECTION: Grammar School, West Bromwich, "Industrial Relations," T. Wylie, 7.45 p.m.

Institute of Marine Engineers

Tues., May 8th.—85, Minories, E.C.3, "Marine Torsionmeters and Thrustmeters," R. Cook, 5.30 p.m.

Institute of Petroleum

Wed., May 9th.—26, Portland Place, London, W.1, Symposium on "Combustion Reactions in Relation to Gas Turbine Practice," 4 p.m.

Institute of Road Transport Engineers

To-day, May 4th.—E. MIDLANDS CENTRE: Miltons Head Hotel, Nottingham, Annual General Meeting and Dinner, 6.30 p.m.

Fri., May 11th.—South Wales Institute of Engineers, Park Place, Cardiff, "Engine Bearings," 7 p.m.

Institution of Civil Engineers

To-day, May 4th.—N.W. ASSOCIATION: Engineers' Club, Albert Square, Manchester, Annual General Meeting, "Impressions of a Tour of the U.S.A. with the British Opencast Coal Mission," A. Monk, 6.30 p.m.

Tues., May 8th.—Great George Street, Westminster, S.W.1, "Prestressed Concrete Applied to the Construction of Railway Bridges and Other Works," Arthur Dean, 5.30 p.m.

Institution of Electrical Engineers

Mon., May 7th.—S. MIDLAND CENTRE: James Watt Memorial Institute, Great Charles Street, Birmingham, "The Application of Gas-Turbine Technique to Steam Power," J. F. Field, 6 p.m.

Tues., May 8th.—N. MIDLAND CENTRE: Queen's Hotel, Leeds, Annual General Meeting, "Mind and Invention," G. P. Meredith, 6.30 p.m.

Wed., May 9th.—RADIO SECTION: Savoy Place, Victoria Embankment, W.C.2, Symposium of Papers on "The Sutton Coldfield Television Station," 5.30 p.m.

Institution of Mechanical Engineers

To-day, May 4th.—Storey's Gate, St. James's Park, S.W.1, "Stages in the Design of the Large Burmeister and Wain Marine Diesel Engine," H. H. Blache, 5.30 p.m.

Institution of Post Office Electrical Engineers

Tues., May 8th.—Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2, "Trunk Mechanisation," J. H. Broadhurst and A. J. Thompson, 5 p.m.

Institution of Production Engineers

Tues., May 8th.—BIRMINGHAM GRADUATE SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Fundamental Machining Problems Associated with the Production of Gas Turbine Components," P. Spear, 7 p.m.

Thurs., May 10th.—SOUTHERN SECTION: Polygon Hotel, Southampton, "Planning for Production Incorporating Cost Control," C. W. Higgins, 7 p.m.

Institution of Structural Engineers

Wed., May 9th.—YORKSHIRE BRANCH: Great Northern Hotel, Leeds, Annual General Meeting, "Construction of 240ft Clear Span Sheds for Aircraft Production," J. G. Faber, 6.30 p.m.

Royal Institution of Chartered Surveyors

Mon., May 7th.—12, Great George Street, Westminster, S.W.1, "Mineral Valuations Under the Town and Country Planning Act, 1947," J. D. Trustram Eve, 5.30 p.m.

Society of Chemical Industry

Thurs., May 10th.—Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, Annual General Meeting, "Pitch and Pitch Mastics as Colloidal Systems," L. J. Wood, 6 p.m.

Society of Engineers

Mon., May 7th.—Geological Society, Burlington House, Piccadilly, W.1, "The Submersible Pump," Bernard Payne, 5.30 p.m.

Women's Engineering Society

Tues., May 8th.—35, Grosvenor Place, London, S.W.1, "The Engineering of Amusements," 7 p.m.

British Standards Institution

*All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.*1.

GIN BLOCKS

No. 1692 : 1950. This Standard relates to fibre rope gin blocks used for hoisting or lowering materials and other light loads by hand or by portable hand winches. Four sizes of block, considered sufficient for normal requirements, are specified. These are 4in, 8in, 12in and 16in, the sizes representing the outside diameter of the sheave. A specification covers the quality of the materials required for the various components and includes details of clearances, tolerances and marking. A table gives the form and dimensions of the component parts of the gin block, together with an associated drawing. Another table and drawing is concerned with the particulars of hooks and includes the related safe working and proof loads. An appendix illustrates the form of certificate of test and examination. Price 2s.

MERCURY ARC RECTIFIER EQUIPMENTS

No. 1698 : 1950. This British Standard, which is the culmination of many years of research and discussion, has been subject to some delay due to parallel discussions which have been taking place in a Technical Committee of the International Electrotechnical Commission. The recommendations of the I.E.C. have been taken into account in preparing the British Standard. It applies to mercury arc rectifier equipments comprising half-wave rectifiers of any type having mercury pool cathodes, rated at 50kW and above, having not less than six phases, for d.c. voltages not exceeding 4000V, and for service in non-explosive atmospheres.

The standard includes sections on definitions, rating classes and overloads, rectifier and associated auxiliaries, main and inter-phase transformers and performance and high-voltage tests applying thereto. Efficiency, power factor and regulation are also dealt with and the appendices include service conditions, reduction of limits of temperature rise, for ambient or coolant temperatures higher than standard, calculation of r.m.s. currents in transformers, method of calculating inherent regulation, and information which is required to be given with enquiries for these equipments. Price 5s.

THE ASSESSMENT OF SURFACE TEXTURE (CENTRE-LINE AVERAGE HEIGHT METHOD)

No. 1134 : 1950. This British Standard, which is of interest to engineers in most sections of industry, refers to the measurement of the irregularities of metal surfaces machine-finished by various methods. Although relating primarily to these surfaces, the principles may be usefully extended to the wider field of surfaces produced by other methods. The subject matter covers terminology, the instruments and methods to be employed in assessing British Standard index numbers for surface texture, preferred limits for the grading of surface texture by means of index numbers and the symbols to be employed in stating surface texture requirements on drawings.

There are appendices which supplement and explain some of the reasons for the recommendations made in the body of the Standard; they contain useful notes indicated by the titles: remarks on surface profiles, the determination of C.L.A. index numbers, notes on the direction of measurement, notes on instrumentation, notes on the measurement of longer sampling lengths, the analysis of surface texture, choice of sampling lengths and, finally, alternative assessments of surface texture. A number of diagrams are shown illustrative of various types of surface and the whole constitutes a useful addition to the literature on the subject as it brings together much that has hitherto been scattered throughout various publications. The latest available information, hitherto unpublished, on methods of measurement, is also given. Price 6s.

X-RAY DIFFRACTION POWDER CAMERAS

No. 1693 : 1950. For some time past a need has been felt for standardisation in the design of X-ray diffraction cameras, particularly powder cameras; the Committee of the X-Ray Analysis Group of the Institute of Physics, therefore, drew up a set of recommendations, which formed the basis of a new British Standard, which has just been published. This British Standard deals with two sizes of X-ray diffraction powder cameras as follows. First, cameras having a nominal diameter of 9cm, which are intended for use at room temperatures where the film is mounted by the Van Arkel or by the Bradley-Jay method. Secondly, cameras having a nominal diameter of 19cm, which applies to cameras with fixed or removable film holder, in which the type is mounted on or as a fibre of small diameter with provision for rotation or oscillation.

It sets out full details of general construction, dimensions, covers, specimen rotation and camera mounting and includes clauses on mechanical assembly and testing. The publication of this standard should facilitate the comparison of films taken in different laboratories and should, in addition, be of use to manufacturers of associated apparatus, such as micro-photometers and measuring instruments. Price 2s.

GRAPHICAL SYMBOLS FOR INSTRUMENTATION

No. 1646 : 1950. The system of instrument symbols described in this document provides a means of graphical representation suitable for use in any engineering or process-line diagram. It is also suitable for use in engineering and industrial reports and in plant arrangement and lay-out drawings. The symbols are not primarily intended for use in electrical wiring diagrams, nor are they intended to detail any particular type of instrument or control. The system has been devised in simple form to enable any combination of instruments or control equipment to be shown in relation to the units of the plant with which they are associated. It is designed to be flexible so that alterations of instrumentation at successive stages of design may be readily shown on a line diagram in such detail as the system permits. Three diagrams are included only to illustrate the application of this system of symbols. The notation used with the symbols provides a general indication of the kinds of instruments and controls represented. These indications should be supplemented by more detailed and informative data sheets or "instrument lists," covering the exact specifications of the equipment required. Systems for the numbering of instruments are not dealt with in this Standard. It is assumed that numbering systems already in use in individual cases can provide the necessary detailed references to data sheets or "instrument lists." Price 2s. 6d., post free.